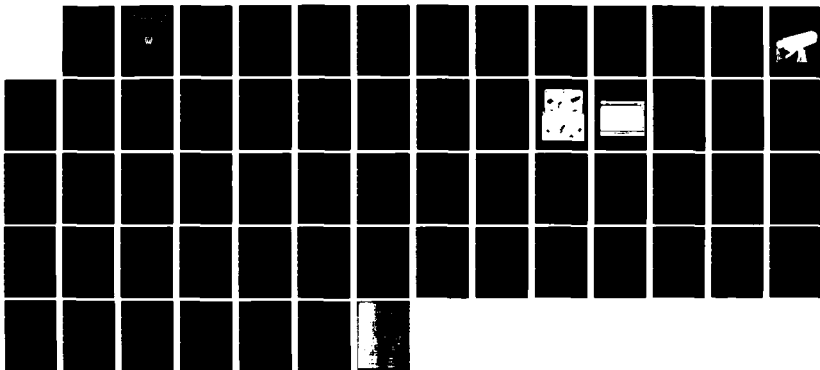


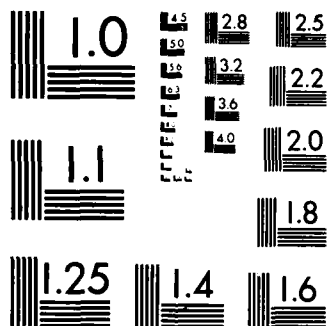
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(2)

BATTLEFIELD IDENTIFICATION FRIEND - OR - FOE (BIFF) - THERMAL SIGHT TRAINER

**BY Albert Marshall
Gary Bond
Bon Shaw**



PREPARED FOR

**U.S. ARMY PROJECT MANAGER FOR TRAINING DEVICES
NAVAL TRAINING EQUIPMENT CENTER (NTEC)
ORLANDO, FLORIDA 32813**

BY

**ADVANCED SIMULATION CONCEPTS LABORATORY
SIMULATION TECHNOLOGY BRANCH**

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)		
<p>Few Army units have access to the ranges and opposing force vehicles required for "real-world" training in thermal-image friend-foe discrimination and specific-vehicle identification. Even given facilities, such training is time-and-resource-expensive. This report describes a low-cost interactive trainer concept developed to provide classroom or day-room training under simulated operational conditions.</p>		

This effort employs a commercial-type riflescope with coaxially-mounted collimated light source as a substitute for the operational thermal sight. Through this "sight" the student views a highly-detailed replaceable scale model of the selected vehicle; each model is painted (with retroflective paint) in pattern replicating the real-world thermal signature under specified conditions. The model is mounted on a turntable, permitting presentation of either static or moving views from/to any quarter. Models could be prepared so as to replicate signature characteristics under any given operational and environmental conditions.

The system includes a micro-processor which controls the light source and tracks student responses and response times.



1. NAME	
2. GRADE	
3. DATE	
4. TIME	
5. CODES	
6. AND/OR	
7. OTHER	

A

SUMMARY

The Battlefield Identification Friend-or-Foe (BIFF) thermal sight trainer is a device that allows realistic, low-cost training in infrared (IR) target recognition.

Recently, the TOW, DRAGON, and M-1 Tank were equipped with heat-sensitive "IR thermal" night sights. Thermal sights allow the gunner to engage targets through darkness, smoke, dust, and fog that occur on a battlefield. However, thermal images appear different from visual images and require a trained operator. This report describes an experimental trainer developed for BIFF/thermal sight training.

This training device consists of the following components:

- (1) Simulated thermal sight,
- (2) Instructor's console,
- (3) Target board.

The targets are miniature, 1/285 scaled, micro-armor models. When an instructor places a model on the terrain board, he indicates to the system via a switch on his console whether the target is "Enemy" or "Friendly." At the time the instructor is ready to start, he pushes a "START" button which sounds a "Sonalert" buzzer. The buzzer indicates to the student that he can begin when ready. Each student has a simulated thermal sight. The sight has three buttons -- READY, FRIENDLY, and ENEMY. When the student hears the buzzer and is ready to search for a target, he pushes his "READY" button. After he finds the target, he must rapidly identify the target as either "FRIENDLY" or "ENEMY." He does this by pushing the appropriate button on his simulated thermal sight. If he is correct, a computer voice synthesis unit announces his reaction time in seconds. If the student makes an error, the voice synthesis unit announces, "Error." LCD displays on the instructor's console show the student's score as well as average reaction time.

The system design uses an electro-optic approach to simulate thermal targets. The sight is a rifle scope equipped with a thermal sight rubber eyepiece. In very close proximity to the sight is an illumination source consisting of a lens, red filter, and incandescent light bulb. The area illuminated is equivalent to the rifle scope field of view. The miniature targets are painted with retroreflective paint in the normal "Hot" areas, i.e., wheels and engine compartment. Unless the observer's eye is in close proximity to the illuminating source, he does not see the target. However, if he looks through the sight telescope, he sees the magnified target. Since the target is painted to correspond to a real thermal signature, he sees the simulated signature through the sight. Experienced thermal gunners have assessed the image a satisfactory replication of operational sight imagery.

Advantages of the system are:

- (1) Targets move,
- (2) Thermal signatures can be changed,
- (3) Interactive,
- (4) Brightness/contrast control,
- (5) Low cost,
- (6) Competitive training atmosphere,
- (7) Reliable,
- (8) No special instructor training,
- (9) Portable.

The PM TRADE Project Manager is Donald Peckham. The authors wish to thank Mr. Peckham for his assistance on the program.

TABLE OF CONTENTS

	Page Number
I. System Description.....	1
II. System Design	
A. Simulated Thermal Sight.....	4
B. Microcomputer Controller.....	7
C. Computer Synthesized Voice.....	11
D. Rotating Target Board.....	13
E. Power Distribution.....	14
III. Conclusions.....	18
Appendix A. Microcomputer Controller Program.....	A-1
Appendix B. Speech Processor Program.....	B-1

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Page Number</u>
I-1 System Block Diagram	2
II-1 Thermal Sight	4
II-2 Thermal Sight Block Diagram	6
II-3 Instructor's Console Block Diagram	8
II-4 Thermal Sight Schematic	10
II-5 Voice Synthesis Unit	11
II-6 Rotating Target Board	13
II-7 Power Selection Switching	14
II-8 Instructor's Console Schematic	15
II-9 Photograph of Target Board	16
II-10 Photograph of Instructor's Console	17

SECTION I

SYSTEM DESCRIPTION

The Battlefield Identification Friend-or-Foe (BIFF) thermal sight trainer uses an electro-optical approach to simulate thermal imagery. Night sights detect thermal-induced emission or electromagnetic energy in the far IR region. These signals are converted into a visible light image on a LED display screen for real-time viewing by the gunner. The thermal detector in the night sight is capable of resolving small temperature differences.

Thermal target images appear drastically different from visible light presentations. Therefore, the operators require special training in thermal imagery interpretation. The trainee must be capable of identifying both enemy and friendly targets. Since the IR battlefield may contain targets, false targets, and clutter noise, the trainee must be capable of sorting targets rapidly since false target effects can be a principal cause of poor operator performance. False targets might consist of a large rock heated by the sun or a cooking fire.

The approach proposed for a classroom trainer involves the use of miniature models on a small terrain board with easily interchangeable and movable models. Retroreflective paint will be used on target areas that are at a higher temperature, i.e., the engine compartment and road wheels of a tank. False targets, such as hot rocks or fires, will also be easily simulated. Varying the amount of paint on the model can simulate atmospheric effects. The trainee views the target through a low-cost variable magnification rifle scope. The trainee gets the same feel as looking through the real thermal sight scope when searching for a target.

Attached to the sighting scope is a small collimated source of red light. The retroreflective paint on the hot areas of the targets reflects the red light directly back toward the light source in a very narrow cone. Unless an observer has his eye immediately next to the light source, he does not see the retroreflected red light. However, if he places his eye within approximately six inches of the light source, he can see a strong reflection from any surface painted with the retroreflective paint. When the trainee looks through the rifle scope, he sees a magnified image of the retroreflected red light. Magnification values are selected to yield views duplicating those of the AN/TAS-4A and AN/TAS-5 sights at selected ranges. Red was selected to correspond to the LED display screen in the AN/TAS-4A and -5 thermal sights (green can easily be substituted to simulate other sights). Varying amounts of paint or types of retroreflective paint will change the brightness (i.e., target temperature) viewed by the trainee.

To increase the training effectiveness, the system is interactive with immediate voice feedback to the trainee.

Some of the advantages of the system are:

Targets Move - Targets are placed on a rotating disc which continuously varies the aspect of the observed target to the trainee.

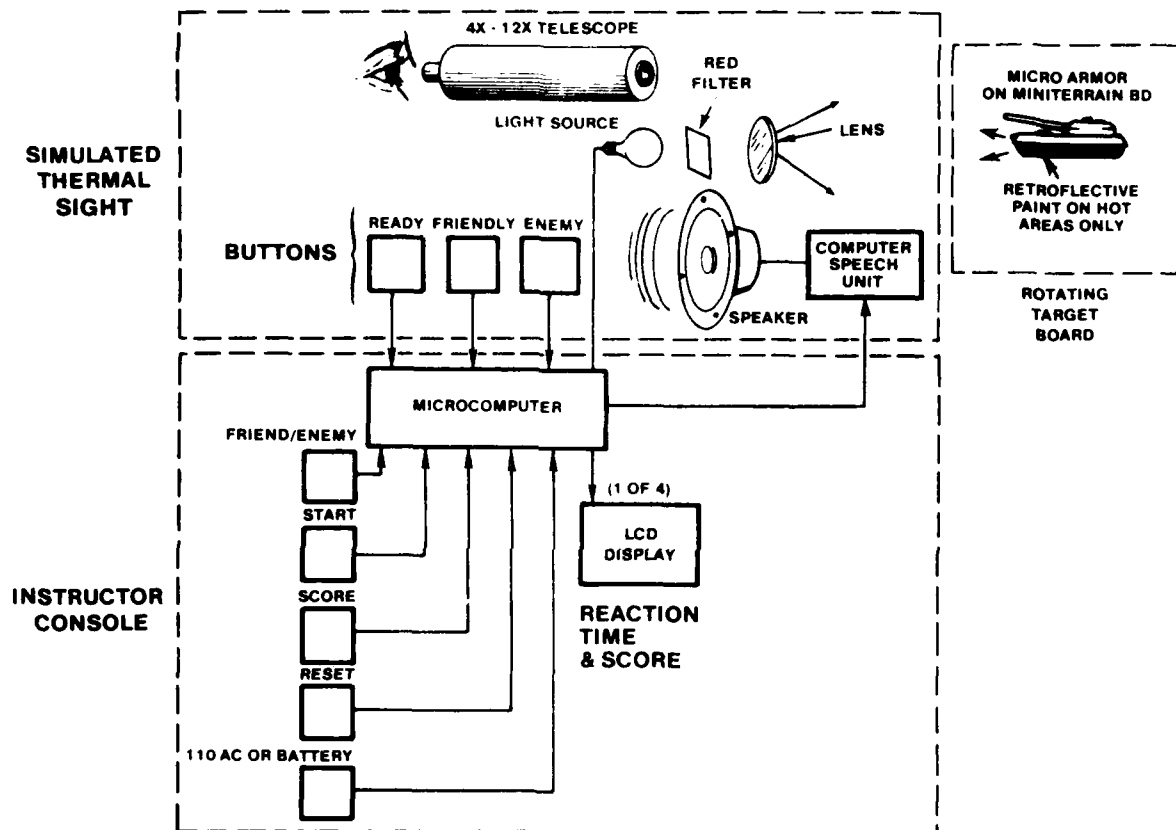


Figure I-1. System Block Diagram

Signatures Can Be Changed - Targets can be painted with a variety of signatures. Signatures can be designed to replicate any definable combination of operational and environmental conditions.

Interactive - Computer synthesized voice gives immediate feedback to trainee on correctness of identification of target as "Friend" or "ENEMY." Reaction time in seconds is separately announced to each trainee.

Brightness/Contrast of Display Can be Varied - The brightness/contrast of the display can be easily varied.

Low Cost - Minimum number of low-cost components.

Reliable - Reliable off-the-shelf microcomputer components.

No Special Operator Training - Operator training can be conducted in less than 0.5 hours.

Portable - High portability.

Figure I-1 shows a system block diagram. The laboratory system has four trainee positions; production unit capacity would be limited only by user defined group size and by capacity of the selected microprocessor.

The main components are:

Simulated thermal sight (1 of 4),

Instructor's console,

Mini-terrain board.

The main system components are discussed in Section II.

Reliable - Reliable off-the-shelf microcomputer components.

No Special Operator Training - Operator training can be conducted in less than 0.5 hours.

Portable - High portability.

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Simulated thermal sight (1 of 4),

Instructor's console,

Mini-terrain board.

The main system components are discussed in Section II.

SECTION II

SYSTEM DESIGN

A. SIMULATED THERMAL SIGHT

The simulated thermal sight laboratory model is shown in Figure II-1 and a block diagram of the simulated thermal sight is shown in Figure II-2. The sight consists principally of a telescopic rifle sight and a target illuminator. The telescope has continuously variable magnification from 4X to 12X and is equipped with an AN/TAS-4 thermal sight eyepiece to heighten the simulation realism.

The illumination source for the retroreflective targets is an incandescent lamp. Light from the lamp is collimated by a simple single biconvex lens. The light is focused to a spot size corresponding roughly to the field-of-view of the sighting telescope. Because both the AN/TAS-4A and AN/TAS-5 thermal sight displays are red (LED), the light source is filtered to correspond to the color of the display. Display brightness is controlled by a potentiometer on the sight.

The simulated sight contains the following buttons and indicators:

READY - The student begins an exercise by pushing this button at any time after the audio signal from the Instructor's console. When the "READY" button is pushed, it:

- (1) Starts the reaction time clock and
- (2) turns on the illuminator so the trainee can see the targets. (When the lamp is off, the target cannot be observed by the trainee.)

FRIEND - When the trainee observes the target, he can select either "FRIEND" or "ENEMY." If the trainee believes the target to be friendly, he/she pushes the "FRIEND" button. This stops the reaction time clock. The synthesized voice announces the reaction time if the selection is correct.

ENEMY - If the student believes the target to be "ENEMY" he/she pushes this button; it, too stops the reaction clock.

Red LED - If the wrong selection is made by the trainee, a red LED is turned on. The LED is located on the sight.

Green LED - If the correct selection is made, the green LED is turned on.

The sight unit contains its own computer voice synthesis module. The speaker for this unit is located in close proximity to the trainee's ear, and the sound level is adjustable.

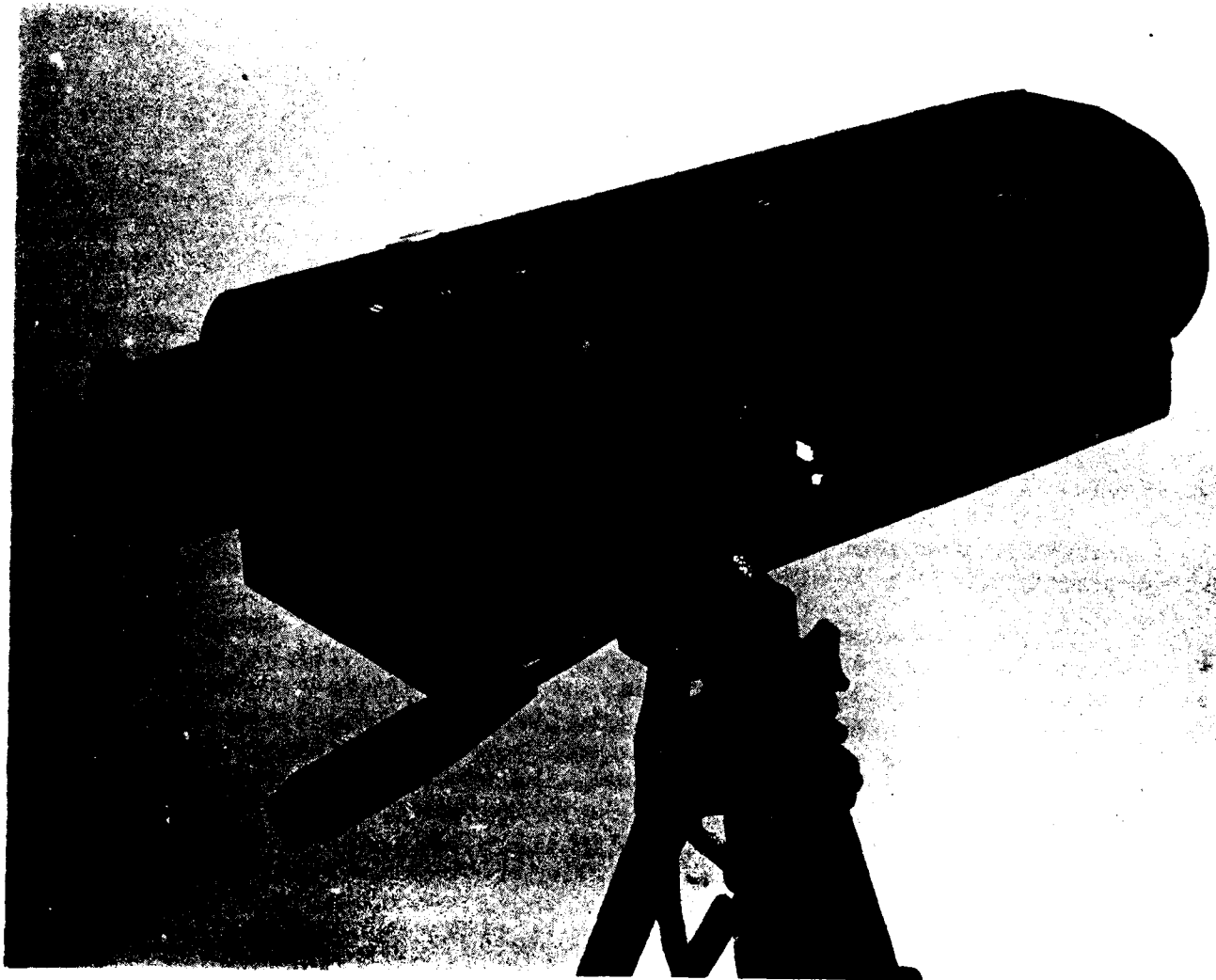


Figure II-1. Thermal Sight

An oscillator causes the target-illuminative incandescent lamp to blink, thus simulating the scanner in the operational thermal sight.

This system is intended to be used in a semi-darkened room. This serves to heighten the effects of the retroreflective approach. Also, trainees can only view targets through an active simulated sight thus providing a measure of control to the instructor.

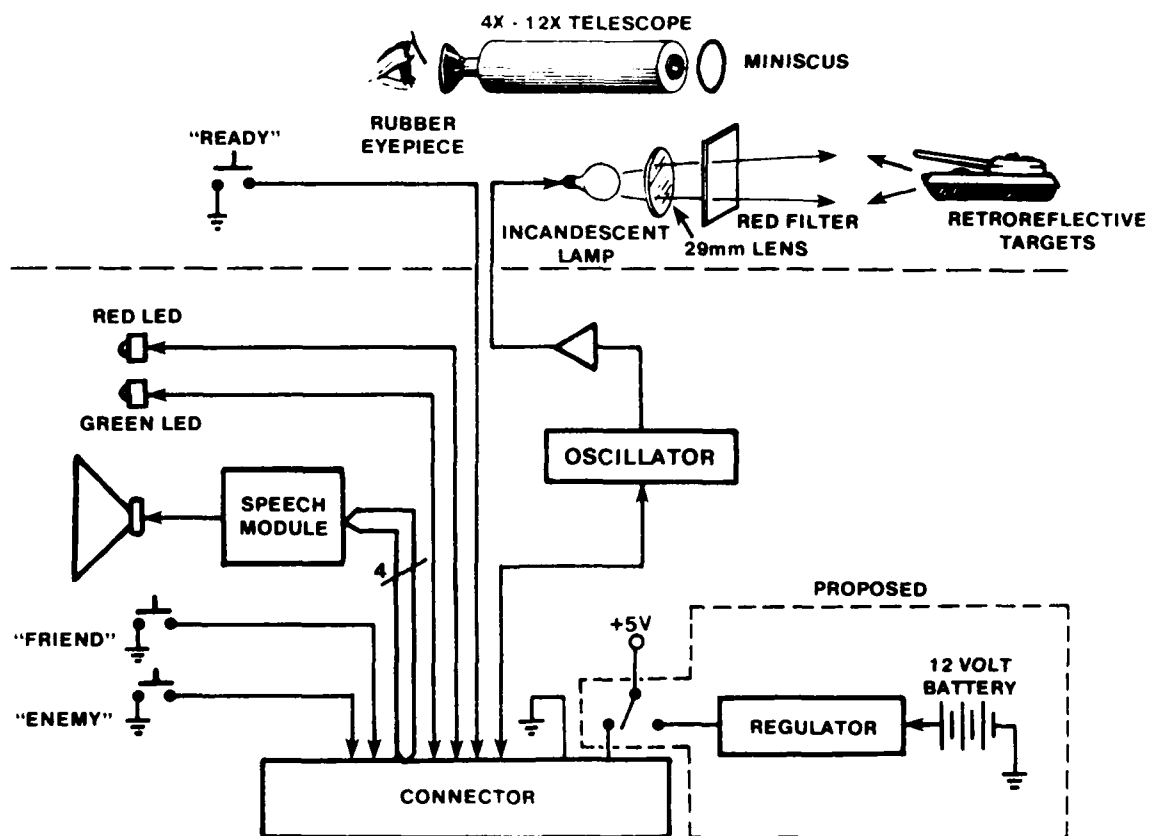


Figure II-2. Thermal Sight Block Diagram

B. MICROCOMPUTER CONTROLLER

All functions of this system are under the control of two single chip microcomputers. The master controller (MC) is an Intel 8748 microcomputer. Its function is to monitor the trainee sights, process information to be displayed on the instructor's console, and route data to its slave speech processor. A complete schematic of the instructor's console is detailed in Figure II-8.

The instructor communicates to the MC via four switches on his console (Figure II-3). The "RESET" switch clears the memory of the MC and initializes the training session. The instructor tells the MC what type target he has selected through the "FRIEND/ENEMY" switch. He then activates the trainee sights with the "START" switch. When he depresses "START," an audio buzzer will sound, notifying the trainees they may begin. Each trainee has three switches on his sight (Figure II-2) -- "READY" turns on the red target illuminator lamp and starts a clock to record his reaction time; "FRIEND" and "ENEMY" tell the MC he has decided what type target and stops his reaction time clock.

The MC utilizes an algorithm which forces a predetermined sequence of events. After reset, MC waits for the "START" signal. When this is received, the type target selected on the instructor's console is stored as 1 for friend and 0 for enemy. A master clock is started, and a buzzer is sounded for one second. At this point, the MC enters a polling algorithm, which monitors the switches on each trainee sight. The timers increment once each 100 milliseconds up to 25.5 seconds.

Two Intel 8243 I/O expanders are used to communicate to the sight switches. Each sight is assigned an 8-bit timer which is cleared and started when the MC detects the "READY" switch depressed. The MC then provides a signal, through the Friendly/Enemy (F/E) 8243, which triggers a 555 Timer. This 555 Timer, located on the sight control board in each sight (Figure II-4), provides a TTL square wave pulse adjustable around 30 Hz to a Darlington driver which activates the target illuminator lamp.

After a trainee has pressed "READY," the MC, through its polling algorithm, waits for the "FRIEND" or "ENEMY" decision. When this choice is made, the MC stores the reaction time present in the timer. Reaction time for each sight is stored in two ways. One 8-bit location in memory is dedicated to each sight and contains the most recent reaction time. Two more 8-bit locations form a 16-bit counter which accumulates reaction time up to a limit of 1.8 hours. The target decision made by the trainee, (friend (1) or enemy (0)), is compared to the instructor's choice. One 8-bit counter for each sight will increment once each time that the trainee's decision is the same as the instructor's. A second 8-bit counter increments each time the trainee makes either decision. These two counters keep track of the trainee's

decision-making progress. The maximum number of decisions (models) which can be made is ninety-nine. Thus, an error is assigned by incrementing only the second counter. If the trainee allows his/her reaction time to reach 25.5 seconds, he/she is automatically assigned an error.

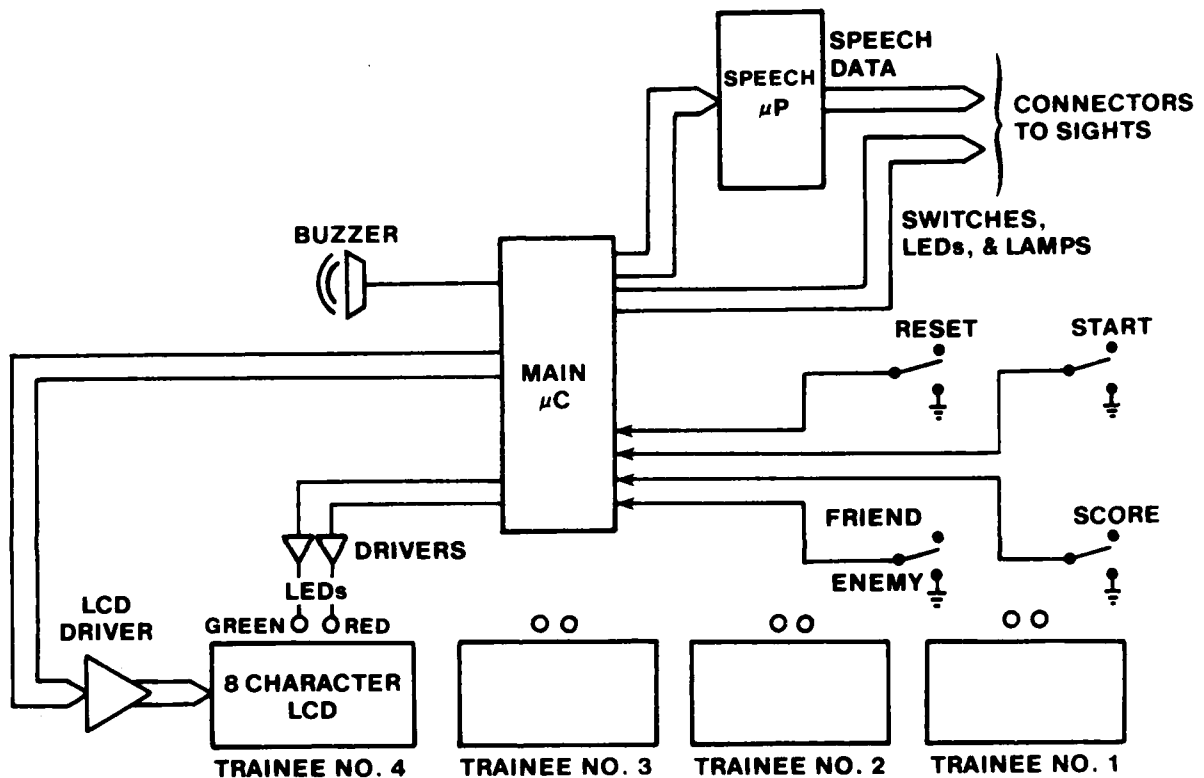


Figure II-3. Instructor's Console Block Diagram

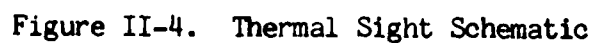
The instructor's console displays the results of each exercise and each trainee's progress through the training session. Four 8-character LCD's are located on the instructor's console, i.e., one per sight. The four left-most characters on each LCD display the trainee's decision-making progress. They represent the number of correct decisions versus the number of decisions, (e.g., 4:9, 18:27, 63:99). The four right-most characters display the most recent reaction time. The MC can calculate an average reaction time using the 16-bit reaction time counters and the counter for the number of decisions made. This average is displayed on the four right-most characters when the "SCORE" button on the instructor's console is pressed.

Two LED's are located just above each LCD, one green and one red; these LEDs work in parallel with those on their respective sights. The MC controls the LED's via the Green/Red (G/R) 8243. When a trainee has made a decision, the MC lights the green LED's if the decision is correct. Likewise, the red LED's go on for an error.

The second microcomputer in the system is the speech processor (SP). It is an Intel 8741 Universal Peripheral Interface. The function of the SP is to control the speechmaking process and operates on an interrupt basis with the MC. Immediately following the display of reaction time, the MC interrupts the SP and passes the reaction time over the data bus. The data passes from the MC to the SP in the form of three encoded 8-bit words. Bits 7 and 6 form the trainee number (0 thru 3) for four trainees. Bits 5 and 4 indicate the digit being passed; 11 for the most significant digit; 10 for the second most significant digit; and 01 for the least significant digit. The four least significant bits contain the Base 10 value of the digit. For example, a reaction time of 13.6 seconds for trainee number 2 is sent in this sequence:

First word	10	11	0001
Second word	10	10	0011
Third word	10	01	0110

The SP transmits data to the voice synthesis modules serially with four lines (see Figure II-4). The speech module requires a 7-bit address and a strobe in order to "Speak." Address bits appear on the "DATA" line and are clocked into the 74164 shift register by pulsing "RESET & CLOCK." This line also resets the speech module. If the SP detects on the "BUSY/READY" line that the speech module is ready, then "STROBE" is pulsed and the address of the word to be spoken is latched into the speech module. For those trainees who make a correct decision, the reaction time is assembled into a stack of addresses within the SP and transmitted to the proper sight. No reaction times are sent for incorrect decisions; instead, the address for "ERROR" is transmitted. The SP operates on a first-in/first-out basis; reaction time and error messages are passed to the proper sight in the order received from the MC.



C. COMPUTER SYNTHESIZED VOICE

A computer synthesized voice is used to give the trainee immediate feedback on both his correctness in identification and reaction time.

If the trainee makes an error, the synthesizer says almost immediately, "Error." If the trainee is correct, the synthesizer announces the time in seconds that the trainee took to recognize the target as "Friend" or "Enemy."

The voice synthesis unit used is a General Instrument VSM 2032 Voice Synthesis Module. This unit is a complete speech system for under \$50.00. It stores thirty seconds of speech and can announce any number from one to one less than a billion.

The synthesis module interfaces with a shift register which provides parallel addresses to the PIC1650A on-board microcomputer. The phrase to be spoken is selected with a 7-bit address. This data is strobed into the module using a STROBE line. Once selected, the VSM 2032 Voice Synthesis Module requires no support from the user's circuit. It enunciates the phrase and signals the voice microprocessor when complete.

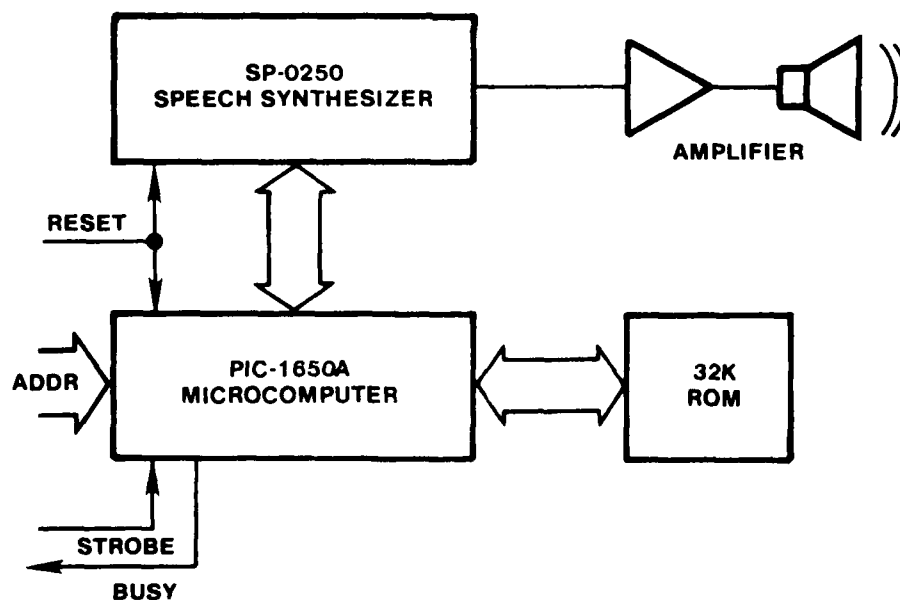


Figure II-5. Voice Synthesis Unit

The standard VSM 2032 used in this system can announce these thirty-two words and syllables:

ZERO	TWEN
ONE	THIR
TWO	FIF
THREE	TY
FOUR	TEEN
FIVE	PLUS
SIX	MINUS
SEVEN	TIMES
EIGHT	OVER
NINE	EQUALS
TEN	POINT
ELEVEN	ERROR
TWELVE	IT IS
HUNDRED	AM
THOUSAND	PM
MILLION	OH

Numbers less than one billion can be enunciated using the above phrase set. For example, 11.4 would be generated by

/eleven/ /point/ /four/

The synthesized voice is human-sounding and very understandable.

The VSM 2032 Voice Synthesis Module contains an operational amplifier which drives a small speaker on the back of each sight, in close proximity to the trainee's ear.

D. ROTATING TARGET BOARD

In order to provide a capability for viewing all aspects of a thermal target, a rotating target board was constructed (Figure II-6). The basic components of the board are:

- (1) 7RPM, 12 VOLT DC motor.
- (2) Aluminum platter.
- (3) Metal suitcase.
- (4) 12 Volt Gel-Type battery.
- (5) Gel-Type battery charger.
- (6) Speed control potentiometer.
- (7) Power switch.

The instructor may rotate the target by simply depressing the power switch. The connection made supplies power to the motor from the Gel-type battery. In series with the battery is a 100 ohm speed control potentiometer which allows the instructor to vary the platter rotational speed. If the battery charger is plugged into 120 VAC, the battery is recharged automatically when the power switch is off.

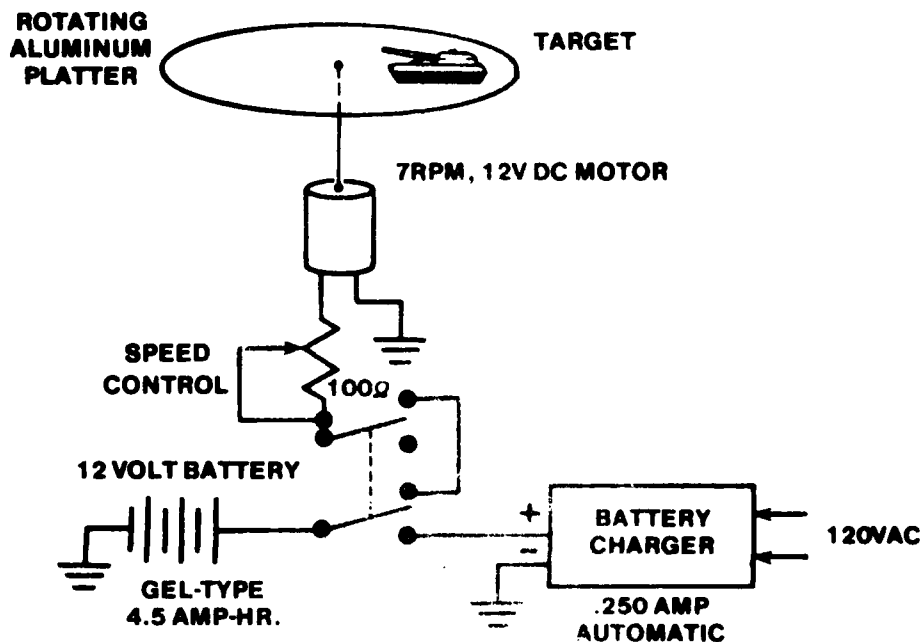


Figure II-6. Rotating Target Board.

E. POWER DISTRIBUTION

When the power selection switch is on "Line", the instructor's console and all the simulated sights are powered from a single, internal 5 volt power supply (see Figure II-7). In this mode or, when the switch is on "OFF" and the console is plugged into 120 VAC, the internal battery is automatically being recharged. If the power selection switch is on "Battery" the instructor's console receives power from the battery but the sights do not. Because of the high current requirements of the incandescent lamps in each sight it is proposed here that a production unit supply battery power to the sights independent of the instructor's console (see Figure II-2).

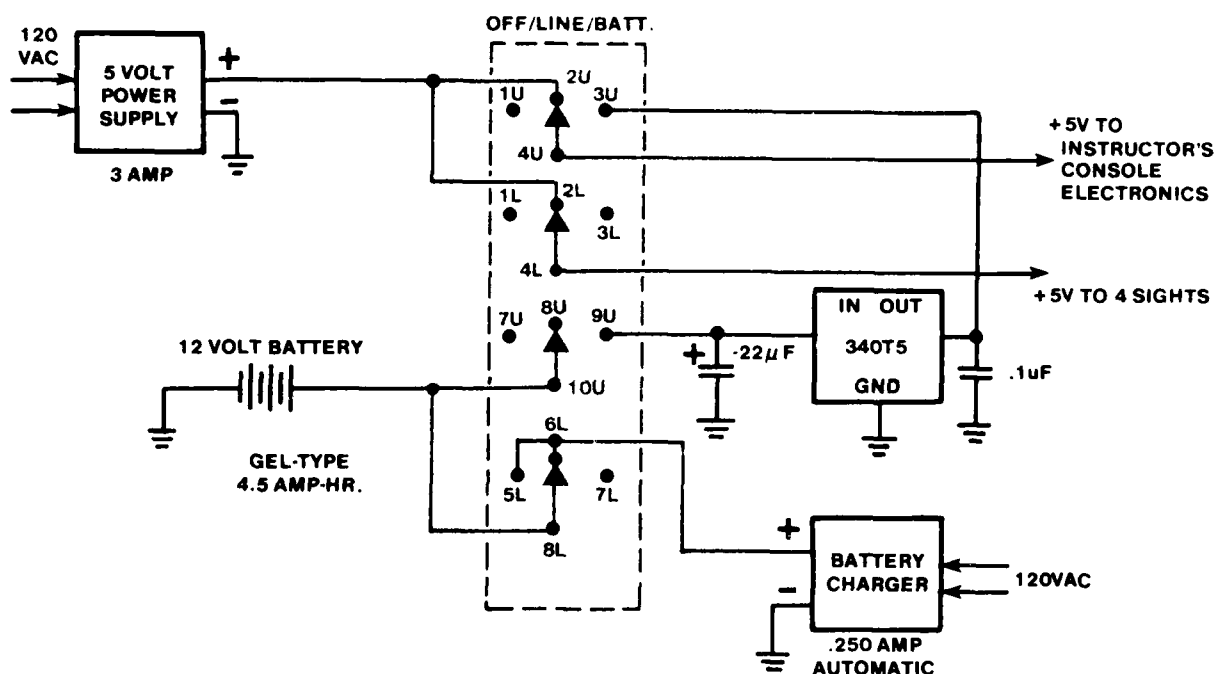


Figure II-7. Power Selection Switching



Figure II-9. Photograph of Target Board

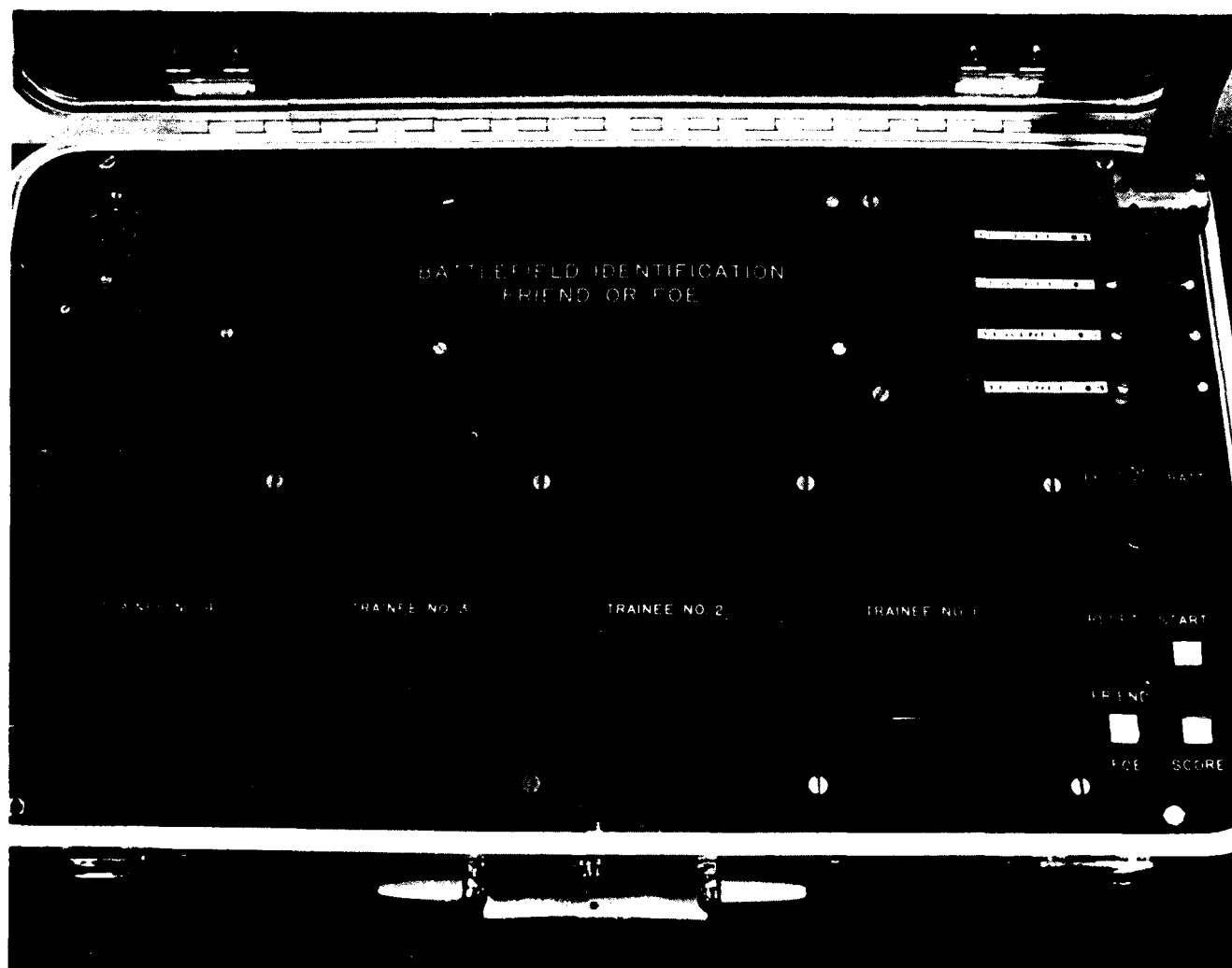


Figure II-10. Photograph of Instructor's Console

SECTION III

CONCLUSIONS

The BIFF system has undergone preliminary evaluation by U.S. Army experienced thermal sight gunners. All gunners were favorably impressed with its realism and interactive teaching attributes.

The method of simulating the thermal sight is the lowest cost method known. The same method is currently used in the STAGS anti-armor gunnery trainer.

Further evaluation will be held in late FY-83.

APPENDIX A
MICROCOMPUTER CONTROLLER PROGRAM

LDC	OBJ	SEQ	SOURCE STATEMENT
		1 ;	19 MARCH 1983
		2	
		3	
		4 ;	BATTLEFIELD IDENTIFICATION FRIEND OR FOE (BIFF)
		5	
		6	
		7 ;	*****
		8	
		9	
		10	
0000		11	ORG 0
0000 27		12	CLR A
0001 B820		13	MOV R0,#020H
0003 B920		14	MOV R1,#020H
0005 0408		15	JMP RAAS
		16	
0007		17	ORG 7
0007 1509		18	JTF TIMER1
0009 449A		19	TIMER1: JMP TIMER
		20	
000B AC		21	RAAS: MOV @R0,A
000C 18		22	INC R0
000D E908		23	DJNZ R1,RAAS
		24	
		25 ;	LOCATION 30H = CURRENT REACTION TIME FOR TRAINEE #1
		26 ;	31H = ' ' ' ' ' #2
		27 ;	' 32H = ' ' ' ' ' #3
		28 ;	' 33H = ' ' ' ' ' #4
		29 ;	
		30 ;	LOCATION 20H & 21H = ACCUMULATED REACTION TIME FOR TRAINEE #1
		31 ;	' 22H & 23H = ' ' ' ' ' #2
		32 ;	' 24H & 25H = ' ' ' ' ' #3
		33 ;	' 26H & 27H = ' ' ' ' ' #4
		34 ;	
		35 ;	LOCATION 34H = MODEL COUNT FOR TRAINEE #1
		36 ;	' 35H = ' ' ' ' ' #2
		37 ;	' 36H = ' ' ' ' ' #3
		38 ;	' 37H = ' ' ' ' ' #4
		39 ;	
		40 ;	LOCATION 38H = ACCUMULATED CORRECT ANSWERS FOR TRAINEE #1
		41 ;	' 39H = ' ' ' ' ' #2
		42 ;	' 3AH = ' ' ' ' ' #3
		43 ;	' 3BH = ' ' ' ' ' #4
		44	
0030		45	CRT1 EQU 030H
0031		46	CRT2 EQU 031H
0032		47	CRT3 EQU 032H
0033		48	CRT4 EQU 033H
		49	
0021		50	ART1 EQU 020H
0022		51	ART2 EQU 022H
0024		52	ART3 EQU 024H

LOC	SEQ	SOURCE STATEMENT	
0026	52	RTA SQL 126H	
	53		
0027	55	BEGIN: STOP TONT	
0028	56	DTS TONTI	
0029	57	MOV A,#8	: START TIMER AT 800 USED TO INSURE
0030	58	MOV 1-A	OVERFLOW AFTER 20 MSIC.
	59		
0031	60	MOV A,#0FFH	: PORT 1 -- LCD DRIVER CHIP SELECTS
0032	61	OUTL P1-A	: P17--AH1 ... P10--110
0033	62	OUTL BUS-A	: BUS PORT: D60 THRU D65 = LCD DRIVER BUS.
0034	63	OUTL P2-A	: PORT 2: P20 THRU P23 = 8243 BUS,
	64		: P24--P25 8243 CHIP SELECT, P27--G/R 8243
	65		: P25--SDALERT 0 = ON.
	66		: P26--FRIEND(1)/ENEMY(0) FOR INSTRUCTOR
	67		
0035	68	ANL P2,#07FH	: P27--0 : CHOOSE G/R
0036	69	CLR A	:
0037	70	MOVD P4-A	: GREEN LED'S. 0 = OFF
0038	71	MOVD P5-A	: RED LED'S. 0 = OFF
0039	72	MOVD A-A	: HIGH IMPEDANCE STATE, PORT 6 --- TRAINEE
0040	73	ORL P1,#080H	: START LINES, P60--#1 ... P63--#4
	74		
0041	75	ANL P2,#0EFH	: P24--0 : CHOOSE P/E
0042	76	MOVD A-P4	: PORT 4 -- TRAINEE TARGET SELECT.
	77		: 1-FRIEND, 0-ENEMY, P40--#1 ... P43--#4
0043	78	MOVD A-P7	: PORT 7 -- TRAINEE DECISION COMPLETE,
	79		: P70--#1, P71--#2, P72--#3, P73--#4.
0044	80	MOVL A,#0FH	: PORT 5 -- INCANDESCENTS FOR SIGHTS,
0045	81	MOVD P5-A	: 1 = OFF, P50--#1 ... P53--#4
0046	82	MOVD P6-A	: P60 IN THE CHIP SELECT FOR THE 8741A
0047	83	ORL P2,#010H	
	84		
0048	85	CALL ERASE	
	86		
0049	87	CLR A	
0050	88	SEL R60	
0051	89	MOV R0-A	: GENERAL PURPOSE REGISTER : DELAY, ECON
0052	90	MOV R1-A	: TIMER INT SUBROUTINE
0053	91	MOV R2-A	: TIMER : :
0054	92	MOV R3-A	: :
0055	93	MOV R4-A	: GENERAL PURPOSE DELAY, ECON
0056	94	MOV R5-A	: TIMER REGISTER
0057	95	MOV R6-A	: TIMER
0058	96	MOV R7-A	: MODEL TYPE: FRIENDLY(0) ENEMY(0)
0059	97	SEL R81	
0060	98	MOV R0-A	: REVISION IN ROUTINE, ROUTE, SCORE
0061	99	MOV R1-A	: : : : SCORE
0062	100	MOV R2-A	: :
0063	101	MOV R3-A	: GENERAL PURPOSE REGISTER
0064	102	MOV R4-A	: TIMER
0065	103	MOV R5-A	: TIMER
0066	104	MOV R6-A	: MODEL TYPE
0067	105	MOV R7-A	: : : : SCORE
0068	106	SEL R81	
	107		

```

LOC 0000      SEQ      SOURCE STATEMENT

0042 4642      108 START: JNT1   START           ; LOOK FOR START SELECTION
0044 BD1E      109          MOV    R5,#300        ; DELAY 300 msec TO LOOK FOR SCORE BUTTON
0046 74C1      110          CALL   DELAY
0048 5654      111          JMI    WHOODIN         ; 'START' + 'SCORE' TURN ON ALL INCANDESCENT
112
004A 2310      113          MOV    A,#010H
004C 74A4      114          CALL   INCAN
004E 8DFF      115          MOV    R5,#0FFH
0050 7421      116          CALL   DELAY           ; 0.5 SEC TO REMOVE FINGERS FROM BUTTONS
0052 0442      117          JMP     START
118
0054 0A        119 WHOODIN: IN     A,P2
0055 0259      120          JB6     FRIEND
0057 045B      121 ENEMY:  JMP     CONSTA         ; ENEMY TARGET CHOSEN R7 REMAINS 0
0059 BF0F      122 FRIEND: MOV    R7,#0FH         ; FRIENDLY TARGET CHOSEN
123
005B 9ADF      124 CONSTA: ANL     P2,#0DFH         ; 1101/1111 SONALERT ON FOR 1 SEC
005D BD64      125          MOV    R5,#100D
005F 7421      126          CALL   DELAY
0061 8A20      127          ORL     P2,#020H
0063 25        128          EN     TCNTI
0064 55        129          STRT    T
130
131
132 ***** SCAN ROUTINE *****
133
134
135 :          START FLAGS: INDICATES TRAINEE IS READY FOR TARGET
136 :                      RB1 R4 B0 <-- TRAINEE #1, START=1
137 :                      RB1 R4 B1 <--      ' #2
138 :                      RB1 R4 B2 <--      ' #3
139 :                      RB1 R4 B3 <--      ' #4
140 :
141 :          FINISHED FLAGS: INDICATES TRAINEE IS DONE WITH THE SCENARIO
142 :                      RB1 R4 B4 <-- TRAINEE #1, FINISHED=1
143 :                      RB1 R4 B5 <--      ' #2
144 :                      RB1 R4 B6 <--      ' #3
145 :                      RB1 R4 B7 <--      ' #4
146 :
147 :          DECISION FLAGS: A '1' INDICATES TRAINEE HAS MADE A DECISION
148 :                      RB1 R5 B0 <-- TRAINEE #1
149 :                      RB1 R5 B1 <--      ' #2
150 :                      RB1 R5 B2 <--      ' #3
151 :                      RB1 R5 B3 <--      ' #4
152 :
153 :          FIRST TIME HERE FLAGS: INDICATES WHEN TO RESET LOCATIONS 30H - 33H
154 :                      RB1 R5 B4 <-- TRAINEE #1, FIRST TIME HERE = 0
155 :                      RB1 R5 B5 <--      ' #2
156 :                      RB1 R5 B6 <--      ' #3
157 :                      RB1 R5 B7 <--      ' #4
158 :
159 :          TARGET ID FLAGS: INDICATES TRAINEE CHOICE OF TARGET IDENTIFICATION
160 :                      RB1 R6 B0 <-- TRAINEE #1, FRIENDLY=1/ENEMY=0
161 :                      RB1 R6 B1 <--      ' #2
162 :                      RB1 R6 B2 <--      ' #3

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PC	DIS	SEQ	SOURCE STATEMENT	PC	DIS	SEQ	SOURCE STATEMENT
163	:			163	:		
164	:			164	:		
165	:			165	:		
166	:			166	:		
0065 140F	167	ROUTE:	ANL R2,#07FH ; CHOOSE G/R				
0066 15	168		SEL RB1				
0068 1E	169		MOVD A,R4				
0069 4C	170		ORL A,R4				
006A 4C	171		MOV R4,A				
006B 8400	172		ORL R2,#020H				
006D 9AEF	173		ANL R2,#0EFH ; CHOOSE F/R				
006F 0F	174		MOVD A,R7				
0070 4C	175		ORL A,R5				
0071 A0	176		MOV R5,A				
0073 05	177		SEL RB0				
0073 B007	178		MOV R5,#2				
0075 7431	179		CALL DELAY				
0077 05	180		SEL RB1				
0078 0C	181		MOVD A,R4				
0079 4E	182		ORL A,R4				
007A AE	183		MOV R6,A				
007B 8A10	184		ORL R2,#010H				
	185						
007D FC	186	CHEP:	MOV A,R4				
007E 92D9	187		JB4 SONNY ; JUMP ON TRAINEE #1 FINISHED				
0080 1284	188		JB0 START1 ; JUMP IF TRAINEE #1 HAS STARTED				
0082 04D9	189		JMP SONNY				
	190						
0084 FD	191	START1:	MOV A,R5				
0085 919C	192		JB4 NFTH1 ; FIRST TIME HERE FLAG				
0087 E034	193		MOV R0,#034H				
0088 1C	194		INC R0 ; INCREMENT MODEL COUNTER FOR #1				
008A D31E	195		MOV A,#01EH				
008B 1444	196		CALL INCAN ; INCANDESCENTS FOR TRAINEE #1 ON				
008E B800	197		MOV R0,#030H				
0091 17	198		CLR A				
0091 4C	199		MOV R6,A ; RESET REACTION TIME FOR TRAINEE #1				
0092 FF	200		MOV A,R7				
0093 040E	201		ANL A,#0EH ; RESET TIME LIMIT FLAG FOR #1				
0095 AF	202		MOI R7,A				
0096 7C	203		MOV A,R5				
0097 04FE	204		ANL A,#0FEH ; RESET DECISION FLAG IF NECESSARY				
0099 4310	205		ORL A,#010H				
009B AC	206		MOV R5,A ; SET FIRST TIME HERE FLAG FOR #1				
	207						
009D 0	208	NFTH1:	MOV A,R5				
009E 1044	209		JB0 DECIS1 ; DECISION MADE CHECK				
00A0 FF	210		MOV A,R7 ; TIME LIMIT CHECK				
00A0 10A8	211		JB0 LIMIT1				
00A2 04D9	212		JMP SONNY ; NO DECISION				
	213						
00A4 0	214	DECIS1:	CLR R0				
00A5 0	215		MOV A,R6				
00A7 0	216		SEL RB0				
00A7 0	217		ORL A,R7 ; PRINT OBJECTS AND GO				

LOC	DEC	SEG	SOURCE STATEMENT
0040 05	218	LIMIT1:	SEL R0: IF TRAINEE INCORRECT. ADD---
0044 0338	219		MOV R0:#038H
0048 0471	220		ANL R2:#07FH
004C 12B6	221	JBO	NCORR1 : JUMP ON INCORRECT
00AF 05	222		CPL F0
00B0 10	223		INC R0
00B1 2301	224		MOV A:#1
00B3 8C	225	ORLD	P4:A : TURN ON GREEN LED #1
00B4 04B9	226		JMP DISP1
00B6 2301	227	NCORR1:	MOV A:#1
00B8 8C	228	ORLD	P5:A : TURN ON RED LED #1
00B9 8A80	229	DISP1:	ORL R2:#080H
	230		
00B8 54D7	231		CALL REACT1 : DISPLAY REACTION TIME FOR TRAINEE #1
00BD 86C1	232		JFO OVER1
00BF 880F	233		MOV R0:#0FH
00C1 74AF	234	OVER1:	CALL VOICE1
	235		
00C1 99FD	236		ANL P1:#0FDH
00C5 8834	237		MOV R0:#034H : DISPLAY # CORRECT VS. MODEL COUNT
00C7 4E	238		CLR F1
00C8 7494	239		CALL SENDUP
00CA 883E	240		MOV R0:#038H
00CD 85	241		CPL F1
00CD 7494	242		CALL SENDUP
00CF 5902	243		ORL P1:#2
	244		
00C1 2301	245		MOV A:#01H
00D3 74A4	246		CALL INCAN : TURN OFF INCANDESCENTS TO #1
	247		
00D8 7C	248		MOV A:R4 : GET FINISHED FLAG FOR TRAINEE #1
00DA 831C	249		ORL A:#010H
00DA 41	250		MOV R4:A
	251		
	252		
	253		
00D8 7C	254	BONNY:	MOV A:R4
00DA 82DE	255		JBS BOND1 : JUMP ON TRAINEE #2 FINISHED
00DC 32F4	256		JBI START2 : JUMP IF TRAINEE #2 HAS STARTED
00DE 2439	257	BOND1:	JMP BOND
	258		
00EA 2404	259	DEIII2:	JMP DECIS2
00E7 00	260		NOP
00E7 00	261		NOP
	262		
00E4 7C	263	START2:	MOV A:R5
00E5 82FC	264		JBS R5THC : TEST FOR FIRST TIME HERE FLAG
00E7 8835	265		MOV R0:#035H
00E9 10	266		INC R0 : INCREMENT MODEL COUNTER FOR #2
00EA 161C	267		MOV A:#010H
00EC 74A4	268		CALL INCAN : INCANDESCENTS FOR #2 GO ON
00EE 8831	269		MOV R0:#031H
00F0 07	270		CLR A
00F0 7C	271		MOV R0:A
00F0 7C	272		MOV A:R7

OBJ	SEG	16-BIT STATEMENT	
0001 0000	073	ANL A,*00H	
0005 48	074	MOV R1,	: SET TIME LIMIT FLAG
0009 01	075	RL A,R1	
0013 00 0	076	MOV A,*000H	: RESET EMISSION FLAG IF NECESSARY
0017 00 0	077	ORL A,*000H	: SET FIRST TIME HERE FLAG
0021 10	078	MOV R5,A	
	079		
0025 00	080 NEXT42:	MOV A,R5	
0029 00 0	081	DETI	: DECISION MADE CHECK
0033 00	082	RL A,R1	
0037 00 0	083	RL A,R1	: TIME LIMIT CHECK
0041 00 0	084	ORL A,R1	: NO DECISION YET
	085		
0045 48	086 DECIS2:	CLR R0	
0049 00	087	MOV A,R1	
0053 00	088	SEL R0	
0057 00	089	RL A,R1	: IF TRAINEE #1 CORRECT: ACC B1 ---0
0061 00	090 LIMIT2:	SEL R0	: IF TRAINEE #2 INCORRECT: ACC B1 ---1
0065 00 0	091	MOV R0,*00H	
0069 00 0	092	ANL R0,*00H	
0073 00 0	093	ORL R0,*00H	: JUMP ON INCORRECT
0077 00	094	ORL R0,*00H	: SET R0 IF CORRECT
0081 10	095	INC R0	
0085 00 0	096	MOV A,*0	
0089 00	097	ORL R0,*0	: TURN ON GREEN LED #2
0093 00 0	098	JMP DISP2	
0097 00 0	099 INCORR2:	MOV A,*0	
0101 00	100	ORL R0,*0	: TURN ON RED LED #2
0105 00 0	101 DISP2:	ORL R0,*00H	
	102		
0109 40 0	103	CALL REACT	: DISPLAY REACTION TIME FOR TRAINEE #2
0113 00 0	104	MOV R0,*00H	
0117 00 0	105	MOV R0,*00H	
0121 00 0	106 OVER2:	CALL REACT	
	107		
0125 00 0	108	ANL R1,*00H	: CHOOSE LED CHI
0129 00 0	109	MOV R0,*00H	: DISPLAY # CORRECT VS. MODEL COUNT
0133 00	110	ORL R1,*00H	
0137 00 0	111	CALL SENDUP	
0141 00 0	112	MOV R0,*00H	
0145 00	113	ORL R1,*00H	
0149 00 0	114	CALL SENDUP	
0153 00 0	115	ORL R1,*00H	
	116		
0157 00 0	117	MOV R0,*00H	
0161 00 0	118	CALL INCRN	: INCR INCR INCR INCR INCR
	119		
0165 00	120	MOV A,*0	
0169 00 0	121	ORL A,*00H	: LED FINISHED FLAG
0173 00	122	MOV R0,*00H	
	123		
0177 00	124 BOND:	MOV A,*0	
0181 00 0	125	ORL A,*00H	: LED ON TRAJEE #3 FINISHED
0185 00 0	126	ORL A,*00H	: LED ON TRAJEE #3 HAS STARTED
0189 00 0	127	JMP JEPN2	

LOC	OBJ	SEQ	SOURCE STATEMENT
		328	
0140 FD		329	START3: MOV A,R5
0141 0256		330	JB6 NFTH3 ; TEST FOR FIRST TIME HERE FLAG
0143 8836		331	MOV R0,#36H
0145 10		332	INC @R0 ; INCREMENT MODEL COUNTER FOR #3
0146 231B		333	MOV A,#01BH
0148 74A4		334	CALL INCAN ; INCANDESCENTS FOR #3 GO ON
014A 8632		335	MOV R0,#032H
014C 27		336	CLR A
014D A0		337	MOV @R0,A ; RESET REACTION TIME FOR TRAINEE #3
014E FF		338	MOV A,R7
014F 530E		339	ANL A,#0BH ; RESET TIME LIMIT FLAG
0151 AF		340	MOV R7,A
0153 FC		341	MOV A,R5
0155 03FB		342	ANL A,#0FEH ; RESET DECISION FLAG
0156 4340		343	ORL A,#040H ; SET FIRST TIME HERE FLAG
0157 AD		344	MOV R5,A
		345	
0158 FD		346	NFTH3: MOV A,R5
0159 5260		347	JB2 DECIS3 ; DECISION MADE CHECK
015B FF		348	MOV A,R7 ; TIME LIMIT CHECK
015C 5264		349	JB2 LIMIT3
015E 2495		350	JMP JEANNE
		351	
0160 35		352	DECIS3: CLR F0
0161 FE		353	MOV A,R6
0162 05		354	SEL RB0
0163 DF		355	XRL A,R7 ; IF TRAINEE CORRECT: ACC B2<--0
0164 05		356	LIMIT3: SEL RB1 ; IF TRAINEE INCORRECT: ACC B2<--1
0165 883A		357	MOV R0,#03AH
0167 3A7F		358	ANL P2,#07FH
0169 5271		359	JB2 NDCORF3 ; JUMP ON INCORRECT
016B 35		360	CPL F0 ; SET F0 IF CORRECT
016C 10		361	INC BR0
016D 2304		362	MOV A,#4
016F 7C		363	ORLD P4,A ; TURN ON GREEN LED #3
0170 2475		364	MP DISP3
0172 2304		365	NDCORF3: MOV A,#4
0174 30		366	ORLD P5,A ; TURN ON RED LED #3
0176 5A80		367	DISP3: ORL P2,#080H
		368	
0177 54E3		369	CALL REACT3 ; DISPLAY REACTION TIME FOR TRAINEE #3
0179 647D		370	JFO OVER3
017B 880F		371	MOV R0,#0FH
017D 74E7		372	OVER3: CALL VOICE3
		373	
017F 290F		374	ANL P1,#0DFH ; CHOOSE LCD 361
0181 883A		375	MOV R0,#036H ; DISPLAY # CORRECT VS. MODEL COUNT
0183 AF		376	CLR F1
0184 7494		377	CALL SENDUP
0186 883A		378	MOV R0,#03AH
0188 35		379	CPL F1
0189 7494		380	CALL SENDUP
018B 2916		381	ORL P1,#020H
		382	

LOC	DEL	SEG	SOURCE STATEMENT	
0180	1304	383	MOV A:04H	
0181	7444	384	CALL INCAH	INCAH INCREMENTS TO #3
		385		
0181	FD	386	MOV A:8H	
0182	4140	387	DRL A:040H	LEFT FINISHED FLAG
0184	AD	388	MOV R4:4	
		389		
0185	FD	390	JEANNE: MOV A:8H	
0186	FDH	391	JBT SCAR	IF JBT ON TRAINEE #4 FINISHED
0186	7290	392	JB3 START4	IF JBT ON TRAINEE HAS STARTED
0184	74F1	393	JMP SCAR	
		394		
0185	FD	395	START4: MOV A:8H	
0186	F2B4	396	JBT NF04H	IF FIRST TIME HERE FLAG CHECK
018F	5837	397	MOV R0:030H	
01A1	10	398	INC R0	INCREMENT MODEL COUNTER FOR #4
01A2	2317	399	MOV A:017H	
01A4	7444	400	CALL INCAH	INCAH INCREMENTS
01A6	B833	401	MOV R0:030H	
01A8	27	402	CLR A	
01A9	A0	403	MOV R0:04H	IF REEST REACTION TIME
01A4	FF	404	MOV A:8H	
01A8	5307	405	ANL A:07	
01AD	AF	406	MOV R7:4	IF REEST TIME LIMIT FLAG FOR #4
01AE	FD	407	MOV A:0H	
01AT	53F7	408	ANL A:047H	IF REEST DECISION FLAG
01B1	4380	409	DRL A:080H	IF REEST FIRST TIME HERE FLAG
01B3	AD	410	MOV R0:4	
		411		
01B4	FD	412	NETH4: MOV A:8H	
01B5	71BD	413	JBT DECIS4	IF DECISION MADE CHECK
01B7	FF	414	MOV A:07	
01B8	7000	415	JBT LIST4	IF LIST CHECK
01BA	24F1	416	JMP SCAR	IF DECISION
		417		
01B8	FD	418	DECIS4: CLF FC	
01B1	76	419	MOV A:0H	
01BF	FD	420	SEL R0	
01C0	FD	421	XRL A:07	IF CORRECT: ADD B3C--0
01C1	FD	422	INIT4: SEL R0	IF INCORRECT: ADD B3C--1
01C2	FD	423	MOV R0:03EH	
01C3	FD	424	ANL R2:047H	
01C4	FD	425	JBT R0:047H	IF CORRECT INCURRED
01C5	FD	426	CPH R0	IF CORRECT
01C6	FD	427	INP R0	
01C7	FD	428	MOV A:4H	
01C8	FD	429	CALL INCAH	
01C9	FD	430	JMP	
01CA	FD	431	MOV A:0H	
01CB	FD	432	CALL INCAH	
01CC	FD	433	DECIS4: JAL R0:4	
		434		
		435		
		436		
01D0	2004	437	MOV R0:047H	

LOC	OBJ	SEQ	SOURCE STATEMENT
01D9	748F	438	OVER4: CALL VOICE4
		439	
01DB	497F	440	AML P1:#07FH ; CHOOSE LCD 4HI
01DD	8837	441	MOV R0:#037H ; DISPLAY # CORRECT VS. MODEL COUNT
01DF	A5	442	CLF F1
01E0	7494	443	CALL SENDUP
01E2	883B	444	MOV R0:#03BH
01E4	BE	445	CPL F1
01E5	7494	446	CALL SENDUP
01E7	898C	447	ORL P1:#080H
		448	
01E9	2306	449	MOV A:#8
01EB	74A4	450	CALL INCAN ; TURN OFF INCANDESCENTS
		451	
01ED	FC	452	MOV A:R4
01EE	4380	453	ORL A:#080H ; SET FINISHED FLAG
01F0	AC	454	MOV R4:A
		455	
		456	
		457	
		458	*****
		459	
		460	
		461	; SCAN FOR FRIEND, ENEMY, OR SCORE BUTTONS
		462	
01F1	26F5	463	SCAN: JMI REAGAN
01F3	4444	464	JMP SCORE
01F5	58F9	465	REAGAN: JTI BEGIN1
01F7	0465	466	JMP ROUTE
		467	
01F9	040F	468	BEGIN1: JMP BEGIN
		469	
		470	
		471	
		472	
		473	*****
		474	
		475	***** SUBROUTINES *****
		476	
		477	*****
		478	
		479	
		480	
		481	
		482	*****
		483	
		484	; THIS ROUTINE ERASES ANSWER BY WRITING
		485	AN 'F' TO ALL DIGITS OF THE DRIVER.
		486	
01FE	74	487	NOF
		488	
01FC	494B	489	ERASE: MOV R3:#8
01FE	747F	490	MOV R2:#07FH
0200	EA	491	MOV A:R2
0201	7F	492	OUTL P1:A

LOC	OBJ	SEQ	SOURCE STATEMENT
		493	
0202	8C04	494	ECON: MOV R4,#4 ; ERASE 4 DIGITS
0204	88F0	495	MOV RO,#0F0H
0206	F8	496	EASY: MOV A,R0
0207	47	497	SWAP A
0208	90	498	MOVX @R0,A
0209	18	499	INC R0
020A	ED06	500	DJNZ R4,EASY
		501	
020C	FA	502	MOV A,R2
020E	77	503	RR A
020E	AA	504	MOV R2,A
020F	EB00	505	DJNZ R3,ERAE
0211	89FF	506	ORL P1,#0FFH
0213	FC	507	RETR
		508	
		509	*****
		510	
		511	: SCORE (AVERAGE REACTION TIME) ROUTINES
		512	
0214	8934	513	SCORE1: MOV R1,#034H ; MODEL COUNT LOCATION FOR #1
0216	8821	514	MOV RO,#021H ; GET HI BYTE OF #1
0218	99FE	515	ANL P1,#0FEH ; OUTPUT AVERAGE REACTION TIME TO #1
021A	5454	516	CALL SAAB
021C	74AF	517	CALL VOICE1
021E	4447	518	JMP SAE
		519	
0220	8935	520	SCORE2: MOV R1,#035H
0222	8823	521	MOV RO,#023H ; GET HI BYTE OF #2
0224	99FB	522	ANL P1,#0FBH ; OUTPUT AVERAGE REACTION TIME TO #2
0226	5454	523	CALL SAAB
0228	74B3	524	CALL VOICE2
022A	444A	525	JMP SBE
		526	
022C	8936	527	SCORE3: MOV R1,#036H
022E	8825	528	MOV RO,#025H ; GET HI BYTE OF #3
0230	99EF	529	ANL P1,#0EFH ; OUTPUT AVERAGE REACTION TIME TO #3
0232	5454	530	CALL SAAB
0234	74B7	531	CALL VOICE3
023A	444D	532	JMP SCE
		533	
023E	8937	534	SCORE4: MOV R1,#037H
023A	8827	535	MOV RO,#027H ; GET HI BYTE OF #4
023C	99BF	536	ANL P1,#0BFH ; OUTPUT AVERAGE REACTION TIME TO #4
023E	5454	537	CALL SAAB
0247	74B6	538	CALL VOICE4
024E	4450	539	JMP WABF
		540	
0244	FC	541	SCORE: MOV A,R4 ; SCORE ONLY THOSE TRAINEES THAT HAVE FINISHED
0245	9214	542	JB4 SCORE1
0247	FC	543	SAE: MOV A,R4
0248	8220	544	JB5 SCORE2
024A	FC	545	SBE: MOV A,R4
024B	0220	546	JB6 SCORE3
024D	FC	547	SCE: MOV A,R4

LOC	DB	SEQ	SOURCE STATEMENT
024E	F238	548	JB7 SCORE*
		549	
0250	4650	550	WASP: JNT1 WASP
0252	0A0F	551	JMP BEGIN
		552	
0254	97	553	SAAB: CLR C
0255	35	554	CLR F0
0256	F1	555	MOV A+R1
0257	AE	556	MOV R6+A
0258	F8	557	MOV A+R0
0259	AD	558	MOV R5+A
025A	8B00	559	MOV R3+R0
025B	F0	560	MOV A+R0 ; GET HI BYTE INTO ACC
025D	AF	561	MOV R7+A
025E	FF	562	SAAC: MOV A+R7
025F	0667	563	JZ SAAC
0261	07	564	DEC A
0262	4F	565	MOV R7+A
0263	54AF	566	CALL HISC
0265	44EE	567	JMP SAAC
0267	F0	568	SAAC: MOV A+R5
0268	97	569	DEC A
0269	AC	570	MOV R0+A ; R0 GETS ADDRESS OF LO BYTE
026A	5482	571	CALL LISC
026B	FE	572	MOV A+R3
026D	6400	573	JMP SEND
		574	
		575	*****
		576	
		577	HIGH BYTE DIVIDE SUBROUTINE
		578	
026F	97	579	HISC: CLR C
0270	37	580	CLR A
0271	A8	581	HI4: MOV R0+A
0272	5E	582	ADD A+R6
0273	5470	583	JC HIB
0275	18	584	INC R3
0276	837	585	JPL -HIA
0278	07	586	DEC A
0279	95	587	CPL F0
027A	4471	588	JMP HIA
027D	58	589	HIB: MOV A+R0
027E	07	590	CPL A
027F	8823	591	MOV R0+R0B+
0280	AC	592	MOV R0+A ; R0H GETS REMAINDER OF HI BYTE DIVIDE
0281	93	593	RETR
		594	
		595	*****
		596	
		597	LOW BYTE DIVIDE SUBROUTINE
		598	
0282	97	599	LISC: CLR C
0283	07	600	MOV A+R0
0284	07	601	CPL A
0285	AC	602	MOV R0+A

LOC	OBJ	SEQ	SOURCE STATEMENT
0286	6E	603	ADD A,R6
0287	F68C	604	JC LOB
0289	1B	605	INC R3
028A	4485	606	JMP LOA
028C	7B	607	LOB: MOV A,R0
028D	37	608	CPL A ; ACC GETS REMAINDER OF LO BYTE DIVIDE
028E	B82B	609	MOV R0,#028H
0290	6C	610	ADD A,R0 ; ACC GETS SUM OF TWO REMAINDERS
0291	97	611	CLR C
0292	37	612	CPL A
0293	6E	613	LOC: ADD A,R6
0294	F699	614	JC LOD
0296	1B	615	INC R3
0297	4493	616	JMP LOC
0299	73	617	LOD: RETR
		618	
		619	;XX
		620	
		621	; TIMER SERVICE INTERRUPT ROUTINE
		622	
		623	; THE TIMER REGISTER (T) INCREMENTS EVERY 80 USEC AND
		624	OVERFLOWS AT 20 MSEC.
		625	
		626	; R0 R2 OVERFLOWS AT 5XT = 100 MSEC. R0 R3 COUNTS THE
		627	NUMBER OF R2 OVERFLOWS.
		628	
029A	05	629	TIMER: SEL R0
029B	4B	630	MOV R3,A
029C	2306	631	MOV A,#6
029E	62	632	MOV T,A ; RESTORE 480 USEC TO TIMER REGISTER
029F	EA01	633	DJNZ R2,TIMRET
02A1	B970	634	MOV R1,#030H
02A3	B404	635	MOV R2,#4
02A5	235F	636	TIMDOT: MOV A,#0FFH ; TEST FOR 25.5 SEC LIMIT
02A7	01	637	XRL A,R1
02A8	940B	638	JNZ TIMOUT
02AA	F	639	MOV A,R1
02AB	05	640	SEL R0
02AC	028C	641	JB1 TIME
02AE	12B6	642	JB0 TIMA
02B0	FF	643	MOV A,R7
02B1	4301	644	ORL A,#1
02B2	AF	645	MOV R7,A ; R1 = 30H
02B4	440B	646	JMP TIMCL
02B6	FF	647	TIMA: MOV A,R7 ; R1 = 31H
02B7	4302	648	ORL A,#2
02B9	AF	649	MOV R7,A
02BA	440B	650	JMP TIMCL
02BC	1204	651	TIMB: JS0 TIMC
02BE	FF	652	MOV A,R7 ; R1 = 32H
02BF	4304	653	ORL A,#4
02C1	AF	654	MOV R7,A
02C2	440B	655	JMP TIMCL
02C4	FF	656	TIMC: MOV A,R7 ; R1 = 33H
02C5	430B	657	ORL A,#B

LOC	OBJ	SEQ	SOURCE STATEMENT
02C7	AF	658	MOV R7,A
02C8	C5	659	TIMCL: SEL R80
02C9	440C	660	JMP TIMLIM
		661	
02CB	11	662	TIMCUT: INC @R1
02CC	19	663	TIMLIM: INC R1
02CD	EAA5	664	DJNZ R2,TIMDOT
02CF	BA05	665	MOV R2,#5 ; RESTORE R2
02D1	FB	666	TIMRET: MOV A,R3
02D2	93	667	RETR
		668	
		669	*****
		670	
		671	; REACTION TIMES ARE STORED AT LOCATIONS
		672	; 30 THRU 33 AND 20 THRU 27. THESE ROUTINES OUTPUT TO THE
		673	; CHOSEN LCD THE BASE 10 TIME.
		674	
02D3	640A	675	RA4444: JMP RAA4
02D5	6402	676	RA2222: JMP RAA2
		677	
02D7	B830	678	REACT1: MOV R0,#CRT1
02D9	B920	679	MOV R1,#ART1
02DB	44ED	680	JMP RACK
02DD	B831	681	REACT2: MOV R0,#CRT2
02DF	B922	682	MOV R1,#ART2
02E1	44ED	683	JMP RACK
02E3	B932	684	REACT3: MOV R0,#CRT3
02E5	B924	685	MOV R1,#ART3
02E7	44ED	686	JMP RACK
02E9	B833	687	REACT4: MOV R0,#CRT4
02EB	B926	688	MOV R1,#ART4
		689	
02ED	97	690	RACK: CLR C
02EE	F0	691	MOV A,@R0
02EF	61	692	ADD A,@R1
02F0	A1	693	MOV @R1,A
02F1	E6F5	694	JNC RACE
02F3	19	695	INC R1
02F4	11	696	INC @R1
02F5	F8	697	RACE: MOV A,R0
02F6	32FC	698	JB1 RACA
02F8	12D5	699	JB0 RA2222
02FA	6406	700	JMP RAA1
02FC	12D3	701	RACA: JB0 RA4444
		702	
02FE	99EF	703	RAA3: ANL P1,#0EFH
0300	640C	704	JMP SAND
0302	99FB	705	RAA2: ANL P1,#0FEH
0304	640C	706	JMP SAND
0306	99FE	707	RAA1: ANL P1,#0FLH
0308	640C	708	JMP SAND
030A	99BF	709	RAA4: ANL P1,#0BFH
		710	
030C	F0	711	SAND: MOV A,@R0
030E	742C	712	SEND: CALL DECODE

LOC	OBJ	SEQ	SOURCE STATEMENT
030F	F8	712	MOV A,R0
0310	4330	714	ORL A,#030H
0312	90	715	MOVX @R0,A
0313	F9	716	MOV A,R1
0314	4320	717	ORL A,#020H
0316	90	718	MOVX @R0,A
0317	FA	719	MOV A,R2
0318	4310	720	ORL A,#010H
031A	90	721	MOVX @R0,A
031B	2505	722	MOV A,#08H
031D	90	723	MOVX @R0,A
031E	89FF	724	ORL R1,#0FFH
0320	93	725	RETR
		726	
		727	*****
		728	
		729	DELAY SUBROUTINE: 10 MSEC PER R5 BIT
		730	
0321	8908	731	DELAY: MOV R0,#8
0323	BCFF	732	LOOP1: MOV R4,#0FFH
0325	EC25	733	LOOP2: DJNZ R4,LOOP2
0327	E8C3	734	DJNZ R0,LOOP1
0329	E021	735	DJNZ R5,DELAY
032B	93	736	RETR
		737	
		738	
		739	*****
		740	
		741	THIS ROUTINE DECODES THE AMOUNT IN THE ACCUMULATOR INTO A
		742	BASE 10 NUMBER.
		743	(R6) R2 = R2 X 100
		744	(R6) R1 = R1 X 10
		745	(R6) R0 = R0 X 1
		746	R3 = GENERAL PURPOSE
0321	8A00	748	DECODE: MOV R2,#0
032E	8900	749	MOV R1,#0
0330	8800	750	MOV R0,#0
0332	F7	751	RLC A
0333	E63A	752	JNC DECA : TEST BIT 7
0335	1A	753	INC R2 : REACTION TIME AT LEAST 12.8 SEC
0336	19	754	INC R1
0337	19	755	INC R0
0338	7484	756	CALL INCR08
033A	F7	757	DECA: RLC A
033E	E641	758	JNC DECF : TEST BIT 6
033D	748D	759	CALL INCR10 : REACTION TIME AT LEAST 6.4 SEC
033F	748E	760	CALL INCR04
0341	F7	761	DECB: RLC A
0342	E648	762	JNC DECD : TEST BIT 5
0344	7490	763	CALL INCR10 : REACTION TIME AT LEAST 3.2 SEC
0346	18	764	INC R0
0347	18	765	INC R1
0348	F7	766	DECC: RLC A
0349	E64E	767	JNC DECD : TEST BIT 4

LOC	ORG	SEQ	SOURCE STATEMENT
0249	19	768	INC R1 ; REACTION TIME AT LEAST 1.6 SEC
0340	7486	769	CALL INCR06
024E	F7	770	DECD: PLC A
034F	E652	771	JNC DECE ; TEST BIT 3
0351	7434	772	CALL INCR09 ; REACTION TIME AT LEAST .8 SEC
0353	F7	773	DECD: RLC A
0354	E659	774	JNC DECF ; TEST BIT 2
0356	7488	775	CALL INCR04 ; REACTION TIME AT LEAST .4 SEC
0358	F7	776	DECF: RLC A
0359	E650	777	JNC DECI ; TEST BIT 1
035B	18	778	INC R0 ; REACTION TIME AT LEAST .2 SEC
035C	18	779	INC R0
035E	F7	780	DECD: RLC A
035E	E641	781	JNC PATTI ; TEST BIT 0
0360	18	782	INC R0 ; REACTION TIME AT LEAST .1 SEC
		783	
		784	
		785	MAX COUNT IN R0 IS 35
		786	MAX COUNT IN R1 IS 15
		787	
0361	F7	788	PATTI: CLR C
0367	18	789	MOV A,R0
0363	37	790	CPL A
0364	030A	791	ADD A,#100
0366	F679	792	JC KAREN ; R0 = 0 TO 9
0368	AB	793	MOV R3,A
0369	19	794	INC R1
036A	030A	795	ADD A,#100
036C	F676	796	JC PATTI ; R0 = 10 TO 19
036E	AB	797	MOV R3,A
036F	19	798	INC R1
0370	030A	799	ADD A,#100
037C	F676	800	JC PATTI ; R0 = 20 TO 29
0374	AB	801	MOV R3,A ; R0 = 30 TO 35
0375	19	802	INC R1
0376	FE	803	PATTI: MOV A,R3
0377	37	804	CPL A
0378	AB	805	MOV R0,A
		806	
		807	DECODE R1 TO INCREMENT R2 IF NECESSARY
		808	
0379	37	809	KAREN: CLR C
037A	FE	810	MOV A,R1
037E	37	811	CPL A
037D	030A	812	ADD A,#100
037E	F693	813	JC PA
0380	1A	814	INC R1
0381	37	815	CPL A
0382	AB	816	MOV R1,A
		817	
0383	93	818	KEN: RETR
		819	
0384	12	820	INCR05: INC R0
0385	13	821	INC R0
0386	12	822	INCR06: INC R1

LOC	OBJ	SEG	SOURCE STATEMENT
0387	18	823	INC R0
0388	18	824	INCR04: INC R0
0389	18	825	INC R0
038A	18	826	INC R0
038B	18	827	INC R0
038C	93	828	RETR
		829	
038D	19	830	INCR16: INC R1
038E	19	831	INC R1
038F	19	832	INC R1
0390	19	833	INCR13: INC R1
0391	19	834	INC R1
0392	19	835	INC R1
0393	93	836	RETR
		837	
		838	
		839	*****
		840	
		841	OUTPUT THE ACC TO THE UPPER TWO DIGITS OF
		842	THE CHOSEN LCD DRIVER.
		843	
0394	F0	844	SENDUP: MOV A,R0
0395	742C	845	CALL DECODE
0397	769B	846	JF1 SENDVR
0399	8A20	847	MOV R2,#020H
039B	F8	848	SENDVR: MOV A,R0
039C	4310	849	ORL A,#010H
039E	4A	850	ORL A,R2
039F	90	851	MOVX @R0,A
03A0	F8	852	MOV A,R1
03A1	4A	853	ORL A,R2
03A2	90	854	MOVX @R0,A
03A3	93	855	RETR
		856	
		857	*****
		858	
		859	ROUTINE TO TURN ON OR OFF THE CHOSEN INCANDESCENT
		860	BIT4 = 0 THEN 'OFF'
		861	BIT4 = 1 THEN 'ON'
		862	
03A4	94EF	863	INCAN: ANL R2,#0EFH
03A6	93AB	864	JB4 INON
03A8	8D	865	INOFF: ORL R5,A
03A9	644C	866	JMP INRET
03AB	9D	867	INON: ANL R5,A
03AC	8A10	868	INRET: ORL R2,#010H
03AF	93	869	RETR
		870	
		871	*****
		872	
		873	PASS DATA TO AN 8741 SPECIFYING THE REACTION TIME IN ORDER
		874	FOR THIS TIME TO BE BROKEN BY THE GI VOICE UNIT.
		875	
		876	IF R7,R6 THEN TRAINEE #1 DATA IS TO BE PASSED.
		877	IF R7,R6 THEN TRAINEE #2

LOC	HEX	SEQ	SOURCE STATEMENT
		378	IF ' = 1 ' #3
		379	IF ' = 2 ' #4
		380	
		381	IF B5:B4 = 1 THEN AC IS SPECIFIED
		382	IF ' = 2 ' R1
		383	IF ' = 3 ' R2
		384	
		385	CHIP SELECT FOR 8741A IS PIN P30 ON THE P/E 8243
		386	
03AF	BB00	387	VOICE1: MOV A, #0
03B1	64B0	388	JMP A, #0
03B3	BB40	389	VOICE2: MOV A, #1
03B5	64B0	390	JMP A, #1
03B7	BB80	391	VOICE3: MOV A, #2
03B9	64B0	392	JMP A, #2
03BB	BB00	393	VOICE4: MOV A, #3
		394	
03BD	PAEF	395	VACE: ANL A, #0EFH
03BF	230E	396	MOV A, #0EH
03C1	3E	397	MOVD P6, A ; CHIP SELECT FOR 8741A
		398	
03C2	F8	399	MOV A, #0 ; CHECK FOR ERROR SIGNAL
03C3	D30F	900	XRL A, #0FH
03C5	C6D3	901	JZ VERR
		902	
03C7	FA	903	MOV A, #0
03C8	4330	904	ORL A, #030H
03CA	4B	905	ORL A, #0
03CB	740F	906	CALL VSEND
03CD	F8	907	MOV A, #0
03CE	4320	908	ORL A, #020H
03D0	4B	909	ORL A, #0
03D1	740F	910	CALL VSEND
03D3	F8	911	VERR: MOV A, #0
03D4	4310	912	ORL A, #010H
03D6	4B	913	ORL A, #0
03D7	740F	914	CALL VSEND
03D9	230F	915	MOV A, #0FH
03DE	3E	916	MOVD P6, A
03DF	9A10	917	ORL A, #0A10H
03DE	93	918	RETR
		919	
03DF	90	920	VSEND: MOVX A, #0
03E0	05	921	SEL R80
03E1	B028	922	MOV R5, #400 ; 200 USCE DELAY
03E3	EDE3	923	VOSEL: DJNZ R5, VSEL
03E5	05	924	SEL R81
03E6	93	925	RETR
		926	
		927	
		928	
		929	END

USER SYMBOLS

ART1 0020 ART2 0021 ART3 0022 ART4 0023 ART5 0024 BEGIN 000F BEGIN1 01F9 BOND 0139 BOND1 00DE

CHEF 0070	CONSTA 0058	CRT1 0030	CRT2 0031	CRT3 0032	CRT4 0033	DECA 003A	DEEF 0041
DECO 0048	DECD 004E	DECE 0053	DECF 0058	DECG 005D	DECIS1 00A4	DECIS2 0104	DECIS3 0106
DECT54 0181	DECODE 032C	DEIII2 00E0	DELAY 0321	DISP1 0089	DISP2 0119	DISP3 0175	DISP4 0101
EASY 0206	ECON 0202	ENEMY 0057	ERAB 0206	ERASE 01FC	FRIEND 0059	HIA 0271	HIE 0270
HISC 026F	INCAN 03A4	INCR04 0388	INCR06 0386	INCR08 0384	INCR13 0390	INCR16 0380	INOFF 03A8
INON 03AE	INRET 03AC	JEANNE 0195	KAREN 0379	KEN 0383	LIMIT1 00A8	LIMIT2 0108	LIMIT3 0164
LIMIT4 0100	LOA 0285	LOB 028C	LOC 0293	LOD 0299	LOOP1 0323	LOOP2 0325	LOSC 028C
NCORR1 00E6	NCORR2 0116	NCORR3 0172	NCORR4 01CE	NFTH1 009C	NFTH2 00FC	NFTH3 0158	NFTH4 0184
OVER1 00C1	OVER2 0121	OVER3 017D	OVER4 0109	PATTA 0376	PATTI 0361	RA2222 02D5	RA4444 02D3
RAA1 0306	RAA2 030E	RAA3 02FE	RAA4 030A	RAAS 000B	RACA 02FC	RACE 02F5	RACY 02ED
REACT1 02D7	REACT2 02D0	REACT3 02E3	REACT4 02E9	REAGAN 01F5	ROUTE 0065	SAAB 0254	SAAC 025E
SAAD 0267	SAE 0247	SAND 030C	SBE 0244	SCAN 01F1	SCE 024D	SCORE 0244	SCORE1 0214
SCORE2 0220	SCORE3 022C	SCORE4 0238	SEND 030D	SENDUP 0394	SENOVR 039B	SONNY 00D9	START 0042
START1 0084	START2 00E4	START3 0140	START4 019C	TIMA 02B6	TIMB 02BC	TIMC 02C4	TIMCL 02C8
TIMCHT 02CB	TIMOOT 02A5	TIMER 029A	TIMER1 0009	TIMLIN 02CC	TIMRET 02D1	VACE 03B0	VERR 03D3
VODEL 03E3	VOICE1 03AF	VOICE2 03B3	VOICE3 03B7	VOICE4 03BB	VOSEND 03DF	WASP 0250	WHOOH 0054

ASSEMBLY COMPLETE, NO ERRORS

APPENDIX B

SPEECH PROCESSOR PROGRAM

LOC	OBJ	SEQ	SOURCE STATEMENT
		1	
		2	
		3	19 MARCH 1983
		4	
		5	
		6	THIS PROGRAM PRODUCES THE SERIAL DATA REQUIRED TO GIVE SPEECH
		7	CAPABILITY TO THE TRAINEE SIGHTS. THE HOST 8748 INTERRUPTS THE
		8	8741 AND SUPPLY'S THE DATA IT NEEDS TO ASSEMBLE REACTION TIMES TO
		9	BE SPOKEN TO EACH OF THE SIGHTS.
		10	
		11	
		12	
0000		13	ORG 0
		14	
0010		15	AMASK1 EQU 00010000B
0020		16	AMASK2 EQU 00100000B
0040		17	AMASK3 EQU 01000000B
0080		18	AMASK4 EQU 10000000B
		19	
0000 0409		20	JMP 9
		21	
0003		22	ORG 3
0003 643E		23	JMP INTER
		24	
0009		25	ORG 9
0009 8D0A		26	RESET: MOV R5,#100
000E 742A		27	CALL DELAY ; DELAY TO INSURE 8748 HAS RESET
000D 05		28	EN I
		29	
000E 23F0		30	MOV A,#0F0H
0010 39		31	OUTL P1,A
0011 23FE		32	MOV A,#0FEH
0012 3A		33	OUTL P2,A
		34	
0014 27		35	CLR A
0015 B821		36	MOV R0,#33D ; COUNTER
0017 B91F		37	MOV R1,#01FH ; POINTER
0019 A1		38	CLEAR: MOV @R1,A ; CLEAR OUT RAM
001A 19		39	INC R1
001B E819		40	DJNZ R0,CLEAR
		41	
001D B800		42	MOV R0,#13D ; COUNTER
001F B933		43	MOV R1,#033H ; POINTER
0021 27		44	CLR A
0022 AA		45	MOV R2,A ; R2 --- DATA
0023 A1		46	INDATA: MOV @R1,A ; SET UP DATA LIST
0024 19		47	INC R1
0025 1A		48	INC R2
0026 FA		49	MOV A,R2
0027 E823		50	DJNZ R0,INDATA
0029 B933		51	MOV R1,#033H ; RESTORE POINTER
		52	

LOC	OBJ	SEQ	SOURCE STATEMENT
002B 1494		53	CALL RESEG
		54	
		55	MAIN LOOP ROUTINE
		56	
002D BC32		57 MAIN:	MOV R4,#032H ; RESERVED STACK POINTER
002F BE14		58	MOV R6,#200 ; RESERVED STACK COUNTER
0031 FD		59	MOV A,R4
0032 AD		60	MOV R0,A
0033 F0		61	MOV A,R0
0034 9640		62	JNZ LOP0
0036 EE3A		63 GETNXT: DGNZ	R6,GETCON ; CHECK FOR BOTTOM OF STACK
0038 0420		64	JMP MAIN
003A CC		65 GETCON: DEC	R4
003B FC		66	MOV A,R4
003C AB		67	MOV R0,A
003D F0		68	MOV A,R0
003E C636		69	JZ GETNXT
		70	
0040 F246		71 LOP0:	JBT LARA ; ACC HAS WORD TO BE SPOKEN
0042 D256		72	JBT TRAC ; TRAINEE #2
0044 044A		73	JMP TRAI ; TRAINEE #1
0046 D26A		74 LARA:	JBT TRAF ; TRAINEE #4
0048 0460		75	JMP TRAC ; TRAINEE #3
		76	
004A 3404		77 TRAI:	CALL DEC001 ; SAY WORD IMMEDIATELY
004C 23FF		78 TDA1:	MOV A,#0FFH ; LOOP UNTIL WORD IS SPOKEN
004E 1479		79	CALL WAIT1
0050 C64C		80	JZ TDA1
0052 1474		81 TRET:	CALL CLR4
0054 0436		82	JMP GETNXT ; CONTINUE DOWN THE STACK
		83	
0056 3486		84 TRAC:	CALL DEC002
0058 D3FF		85 TDA2:	MOV A,#0FFH
005A 147C		86	CALL WAIT2
005C C658		87	JZ TDA2
005E 0452		88	JMP TRET
		89	
0060 5404		90 TRAF:	CALL DEC003
0062 D3FF		91 TDA3:	MOV A,#0FFH
0064 147C		92	CALL WAIT3
0066 C66C		93	JZ TDA3
0068 0452		94	JMP TRET
		95	
006A 548F		96 TRAF:	CALL DEC004
006C D3FF		97 TDA4:	MOV A,#0FFH
006E 147C		98	CALL WAIT4
0070 C66C		99	JZ TDA4
0072 0452		100	JMP TRET
		101	
0074 FD		102 CLR4:	MOV A,R4
0076 AB		103	MOV R0,A
0078 FD		104	CLR A
007A FD		105	MOV R0,A
007C FD		106	RET
		107	

[illegible]

LOC	OBJ	SEQ	SOURCE STATEMENT
		163	;..... ; FIFTH LINE #1
		164	
		165	
0047	B810	166	SPEAK1: MOV R0, #ANASK1
0049	14B5	167	JMP TALK
004B	B820	168	SPEAK2: MOV R0, #ANASK2
004D	14B5	169	JMP TALK
004F	B840	170	SPEAK3: MOV R0, #ANASK3
00B1	14B5	171	JMP TALK
00B3	B8B0	172	SPEAK4: MOV R0, #ANASK4
		173	
00B5	BAD5	174	TALK: MOV R2, #5 ; COUNTER
00B7	37	175	CPL A
00B8	AB	176	MOV R3, A ; STORAGE
00B9	53FE	177	TALA: ANL A, #0FEH ; INQUIRY RESET LINES KEPT HIGH
00BB	3A	178	OUTL P2, A
		179	
00BC	BA01	180	ORL P2, #1 ; CLOCK PULSE
00BE	9AFE	181	ANL P2, #0FEH
		182	
00C0	FB	183	MOV A, R3
00C1	E7	184	RL A
00C2	AE	185	MOV R3, A
00C3	EAE9	186	DJNZ R2, TALA
		187	
00C5	BA64	188	MOV R2, #1000
00C7	EAC7	189	DAY: DJNZ R2, DAY ; NECESSARY DELAY
		190	
		191	; IT IS ASSUMED AT THIS POINT THAT THE VSM IS READY
		192	
00C9	FB	193	STROBE: MOV A, R0
00CA	92DC	194	JB4 STROBE1
00CC	B2DB	195	JB5 STROBE2
00CE	D2D4	196	JB6 STROBE3
		197	
00D0	B90B	198	STROBE4: ORL P1, #3
00D2	04DE	199	JMP STBRET
00D4	B909	200	STROBE3: ORL P1, #4
00D6	04DE	201	JMP STBRET
00D8	04DE	202	STROBE2: ORL P1, #2
00DA	04DE	203	JMP STBRET
00DC	B901	204	STROBE1: ORL P1, #1
		205	
00DE	00	206	STBRET: NOP
00DF	00	207	NOP
00E0	00	208	NOP
00E1	99F0	209	ANL P1, #0F0H
		210	
00E3	BA10	211	MOV R2, #0F0H
00E5	EAE5	212	DEY: DJNZ R2, DEY ; HOLD TIME DELAY
		213	
00E7	99	214	RETF
		215	
		216	;XX
		217	

LOC	OBJ	SEQ	SOURCE STATEMENT
		218	
0100		219	ORG 100H
		220	
0100 641A		221	T1SER1: JMP T1SERR
0102 640A		222	T1SPT1: JMP T1SPT
		223	
		224	
		225	; DECODE THE AMOUNT IN THE ACC FOR TRAINEE #1 TO SPEAK.
		226	
0104 B22D		227	DECODE1: JB5 STEEN1
0106 7435		228	CALL CACC ; CONDITION THE ACC
0108 C600		229	JZ T1SER1 ; "ERROR"
010A 07		230	DEC A
010B C602		231	JZ T1SPT1 ; "POINT"
010D 07		232	DEC A
010E C676		233	JZ T1S20 ; "TWENTY"
		234	
0110 FA		235	MOV A,R2
0111 7229		236	JB3 DAC1
0113 521F		237	JB2 DEC1
0115 321B		238	JB1 DIC1
0117 1254		239	JB0 T1S1 ; "ONE"
0119 2455		240	JMP T1S0 ; "ZERO"
011B 1252		241	DIC1: JB0 T1S3 ; "THREE"
011D 2453		242	JMP T1S2 ; "TWO"
011F 3225		243	DEC1: JB1 DEC1
0121 1250		244	JB0 T1S5 ; "FIVE"
0123 2451		245	JMP T1S4 ; "FOUR"
0125 124E		246	DEC1: JB0 T1S7 ; "SEVEN"
0127 244F		247	JMP T1S6 ; "SIX"
0129 124C		248	DAC1: JB0 T1S9 ; "NINE"
012B 244D		249	JMP T1S8 ; "EIGHT"
		250	
012D 7245		251	STEEN1: JB3 BAA1
012F 523B		252	JB2 BAB1
0131 3237		253	JB1 BAC1
0133 124A		254	JB0 T1S11 ; "ELEVEN"
0135 244B		255	JMP T1S10 ; "TEN"
0137 126E		256	BAC1: JB0 T1S13 ; "THIRTEEN"
0139 2449		257	JMP T1S12 ; "TWELVE"
013E 3241		258	BAB1: JB1 BAD1
013D 1272		259	JB0 T1S15 ; "FIFTEEN"
013F 245F		260	JMP T1S14 ; "FOURTEEN"
0141 125C		261	BAD1: JB0 T1S17 ; "SEVENTEEN"
0143 245D		262	JMP T1S16 ; "SIXTEEN"
0145 125A		263	BAA1: JB0 T1S19 ; "NINETEEN"
0147 245E		264	JMP T1S18 ; "EIGHTEEN"
		265	
		266	; ROUTINE TO CALL UPON TRAINEE #1 TO SPEAK "ZERO" THRU "TWELVE"
		267	
0149 19		268	T1S12: INC R1
014B 19		269	T1S11: INC R1
014E 19		270	T1S10: INC R1
014C 19		271	T1S9: INC R1
014D 19		272	T1S8: INC R1

LOC	ORG	SEQ	SOURCE STATEMENT
014E 19	273	T157:	INC R1
014F 19	274	T156:	INC R1
0150 19	275	T155:	INC R1
0151 19	276	T154:	INC R1
0152 19	277	T153:	INC R1
0153 19	278	T152:	INC R1
0154 19	279	T151:	INC R1
0155 F1	280	T150:	MOV A+@R1
0156 B935	281	T15PM:	MOV R1+@B935 ; RESTORE POINTER
0158 04A7	282	JMP	SPEAK1
	283		
	284 :		SPEAK "THIRTEEN" AND "NINETEEN"
	285		
015A 19	286	T1519:	INC R1
015B 19	287	T1518:	INC R1
015C 19	288	T1517:	INC R1
015D 19	289	T1516:	INC R1
015E 19	290		INC R1
015F 19	291	T1514:	INC R1
0160 19	292		INC R1
0161 19	293		INC R1
0162 19	294		INC R1
0163 F1	295	MOV	A+@R1
0164 14A7	296	TEEN1:	CALL SPEAK1
0166 2014	297	TEN1A:	MOV A+@10100E
0168 1479	298		CALL WAIT1
016A E666	299	JZ	TEN1A
0170 2464	300	JMP	T15PM
	301		
016F 2311	302	T1512:	MOV A+@10001E
0170 2464	303	JMP	TEEN1
	304		
0172 2012	305	T1515:	MOV A+@10010E
0174 2464	306	JMP	TEEN1
	307		
	308 :		SPEAK "NINETEEN"
	309		
0176 2310	310	T1520:	MOV A+@10000E
0178 14A7	311		CALL SPEAK1
017A 2312	312	T152A:	MOV A+@10011E
017C 1479	313		CALL WAIT1
017E E674	314	JZ	TEN1A
0180 04A7	315	JMP	SPEAK1
	316		
	317		*****
	318		
	319 :		DECODE THE POINT IN THE ACC FOR TRAINEE #2 TO SPEAK.
	320		
0182 441E	321	TEEN2:	JMP T15PM
0184 440E	322	TEN2:	JMP T15PM
	323		
0186 B2AF	324	DECODE2:	MOV A+@B2AF
0188 7435	325	JZ	A0 ; CONDITION THE ACC
018A 0681	326	JZ	255H ; "ERROR"
018C 07	327	DEC	A

LOC	OBJ	SEQ	SOURCE STATEMENT
0180	0684	328	JZ T2SPT2 : 'POINT'
018F	07	329	DEC A
0190	06F8	330	JZ T2S20 : 'TWENTY'
		331	
0192	FA	332	MOV A+R2
0193	72AB	333	JB3 DAC2
0195	52A1	334	JB2 DEC2
0197	329D	335	JB1 DIC2
0199	12D6	336	JB0 T2S1 : 'ONE'
019B	24D7	337	JMP T2S0 : 'ZERO'
019D	12D4	338	DIC2: JB0 T2S3 : 'THREE'
019F	24D5	339	JMF T2S2 : 'TWO'
01A1	32A7	340	DEC2: JB1 DEC2
01A3	12D2	341	JB0 T2S5 : 'FIVE'
01A5	24D3	342	JMP T2S4 : 'FOUR'
01A7	12D0	343	DEC2: JB0 T2S7 : 'SEVEN'
01A9	24D1	344	JMP T2S6 : 'SIX'
01AB	12CE	345	DAC2: JB0 T2S9 : 'NINE'
01AD	24CF	346	JMF T2S8 : 'EIGHT'
		347	
01AF	72C7	348	STEEN2: JB3 BAC2
01B1	52B0	349	JB2 BAB2
01B3	32B9	350	JB1 BAC2
01B5	12CC	351	JB0 T2S11 : 'ELEVEN'
01B7	24CD	352	JMP T2S10 : 'TEN'
01B9	12F0	353	BAC2: JB0 T2S13 : 'THIRTEEN'
01BB	24CB	354	JMP T2S12 : 'TWELVE'
01BD	32C3	355	BAB2: JB1 BAD2
01BF	12F4	356	JB0 T2S15 : 'FIFTEEN'
01C1	24E1	357	JMP T2S14 : 'FOURTEEN'
01C3	12DE	358	BAD2: JB0 T2S17 : 'SEVENTEEN'
01C5	24DF	359	JMP T2S16 : 'SIXTEEN'
01C7	12DC	360	BAA2: JB0 T2S19 : 'NINETEEN'
01C9	24D0	361	JMP T2S18 : 'EIGHTEEN'
		362	
		363 :	ROUTINE TO CALL UPON TRAINEE #2 TO SPEAK 'ZERO' THRU 'TWELVE'
		364	
01CB	19	365	T2S17: INC R1
01CC	19	366	T2S11: INC R1
01CD	19	367	T2S10: INC R1
01CE	19	368	T2S9: INC R1
01CF	19	369	T2S8: INC R1
01D0	19	370	T2S7: INC R1
01D1	19	371	T2S6: INC R1
01D2	19	372	T2S5: INC R1
01D3	19	373	T2S4: INC R1
01D4	19	374	T2S3: INC R1
01D5	19	375	T2S2: INC R1
01D6	19	376	T2S1: INC R1
01D7	F1	377	T2S0: MOV R1, R2
01D8	B932	378	T2SFK: MOV R1, R2
01DA	04AB	379	JMF SPEAK
		380	
		381 :	SPEAK 'THIRTEEN' THRU 'NINETEEN'
		382	

LOC	OBJ	SEQ	SOURCE STATEMENT
010C	19	383	T2S19: INC R1
010D	19	384	T2S18: INC R1
010E	19	385	T2S17: INC R1
010F	19	386	T2S16: INC R1
01E0	19	387	INC R1
01E1	19	388	T2S14: INC R1
01E2	19	389	INC R1
01E3	19	390	INC R1
01E4	19	391	INC R1
01E5	F1	392	MOV A, @R1
01E6	14AB	393	TEEN2: CALL SPEAK2
01E8	2314	394	TEN2A: MOV A, #10100B
01EA	147D	395	CALL WAIT2
01EC	06EB	396	JZ TEN2A
01EE	240B	397	JMP T2SPK
		398	
01F0	2311	399	T2S13: MOV A, #10001B
01F2	24E6	400	JMP TEEN2
		401	
01F4	2312	402	T2S15: MOV A, #10010B
01F6	24E6	403	JMP TEEN2
		404	
		405	; SPEAK 'TWENTY'
		406	
01F8	2310	407	T2S20: MOV A, #10000B
01FA	14AB	408	CALL SPEAK2
01FC	2313	409	T2S2A: MOV A, #10011B
01FE	147D	410	CALL WAIT2
0200	0604	411	JZ T2S22
0202	04AB	412	JMP SPEAK2
		413	
0204	24FC	414	T2S22: JMP T2S2A
		415	
		416	;XX
		417	
		418	
0206	6422	419	T3SER3: JMP T3SERR
0208	6412	420	T3SPT3: JMP T3SPT
		421	
		422	
		423	; DECODE THE AMOUNT IN THE ACC FOR TRAINEE #3 TO SPEAK
		424	
020A	B233	425	DECODE3: JB5 STEEN3
020C	7435	426	CALL CACC ; CONDITION THE ACC
020E	0606	427	JZ T3SER3 ; 'ERROR'
0210	07	428	DEC A
0211	0608	429	JZ T3SPT3 ; 'POINT'
0213	07	430	DEC A
0214	067C	431	JZ T3SC0 ; 'TWENTY'
		432	
0216	FA	433	MOV A, R2
0217	722F	434	JB3 DAC3
0219	5215	435	JB2 DEC3
021B	3221	436	JB1 DIC3
021D	125A	437	JB0 T3S1 ; 'ONE'

LOC	OBJ	SEQ	SOURCE STATEMENT
021F	4456	430	JMP T350 ; 'ZERO'
0211	1216	439	DIC3: JB0 T353 ; 'THREE'
0223	4459	440	JMP T357 ; 'TWO'
0225	322B	441	DEC3: JB1 0003
0227	1256	442	JB0 T355 ; 'FIVE'
0229	4457	443	JMP T354 ; 'FOUR'
022B	1254	444	0003: JB0 T357 ; 'SEVEN'
022D	4455	445	JMP T356 ; 'SIX'
022F	1252	446	DAC3: JB0 T354 ; 'NINE'
0231	4453	447	JMP T352 ; 'EIGHT'
		448	
0233	724B	449	STEEN3: JB3 BAA8
0235	5241	450	JB2 BAB1
0237	323D	451	JB1 BAC3
0239	1250	452	JB0 T3511 ; 'ELEVEN'
023B	4451	453	JMP T3510 ; 'TEN'
023D	1274	454	BAC3: JB0 T3513 ; 'THIRTEEN'
023F	444F	455	JMP T3512 ; 'TWELVE'
0241	3247	456	BAB3: JB1 BAC3
0243	1278	457	JB0 T3515 ; 'FIFTEEN'
0245	4465	458	JMP T3514 ; 'FOURTEEN'
0247	1262	459	BAC3: JB0 T3517 ; 'SEVENTEEN'
0249	4463	460	JMP T3516 ; 'SIXTEEN'
024B	1260	461	BAA3: JB0 T3519 ; 'NINETEEN'
024D	4461	462	JMP T3518 ; 'EIGHTEEN'
		463	
		464 ;	ROUTINE TO CALL UPON TRAINEE #3 TO SPEAK 'ZERO' THRU 'TWELVE'
		465	
024F	19	466	T3512: INC R1
0250	19	467	T3511: INC R1
0251	19	468	T3510: INC R1
0252	19	469	T359: INC R1
0253	19	470	T358: INC R1
0254	19	471	T357: INC R1
0255	19	472	T356: INC R1
0256	19	473	T355: INC R1
0257	19	474	T354: INC R1
0258	19	475	T353: INC R1
0259	19	476	T352: INC R1
025A	19	477	T351: INC R1
025B	F1	478	T350: MOV A+GR1
025C	B933	479	T35PK: MOV R1+023F
025E	34AF	480	JMP FDEAN2
		481	
		482 ;	SPEAK 'THIRTEEN' THRU 'NINETEEN'
		483	
0260	19	484	T3519: INC R1
0261	19	485	T3518: INC R1
0262	19	486	T3517: INC R1
0263	19	487	T3516: INC R1
0264	19	488	INC R1
0265	19	489	T3514: INC R1
0266	19	490	INC R1
0267	19	491	INC R1
0268	19	492	INC R1

LOC	OBJ	SEQ	SOURCE STATEMENT
0269	F1	493	MOV A:BR1
026A	14AF	494	TEEN3: CALL SPEAK3
026C	2314	495	TEN3A: MOV A:#10100B
026E	1481	496	CALL WAIT3
0270	066C	497	JZ TEN3A
0272	445C	498	JMP T35PK
		499	
0274	2311	500	T3513: MOV A:#10001B
0276	446A	501	JMP TEFN3
		502	
0278	2312	503	T3515: MOV A:#10010B
027A	446A	504	JMP TEFN3
		505	
		506	; SPEAK 'TWENTY'
		507	
027C	2310	508	T3520: MOV A:#10000B
027E	14AF	509	CALL SPEAK3
0280	2313	510	T352A: MOV A:#10011B
0282	1481	511	CALL WAIT3
0284	0680	512	JZ T352A
0286	04AF	513	JMP SPEAK3
		514	
		515	*****
		516	
		517	; DECODE THE AMOUNT IN THE ACC FOR TRAINEE #4 TO SPEAK.
		518	
0288	6426	519	T4SER4: JMP T4SEPR
028A	6416	520	T4SPT4: JMP T4SPT
		521	
028C	8285	522	DECODE4: JB5 STEEN4
028E	7435	523	CALL CACC ; CONDITION THE ACC
0290	0688	524	JZ T4SEPR ; 'ERROR'
0292	07	525	DEC A
0293	068A	526	JZ T4SPT4 ; 'POINT'
0295	07	527	DEC A
0296	06FE	528	JZ T4S20 ; 'TWENTY'
		529	
0298	FA	530	MOV A:R2
0299	72E1	531	JB3 DAC4
029B	52A7	532	JB1 DEC4
029D	32A3	533	JB1 DIC4
029F	120C	534	JB0 T4S1 ; 'ONE'
02A1	440D	535	JMP T4S0 ; 'ZERO'
02A3	12DA	536	DIC4: JB0 T4S3 ; 'THREE'
02A5	44DB	537	JMP T4S2 ; 'TWO'
02A7	32AD	538	DEC4: JB1 DEC4
02A9	1208	539	JB0 T4S5 ; 'FIVE'
02AB	44D9	540	JMP T4S4 ; 'FOUR'
02AD	1206	541	DEC4: JB0 T4S7 ; 'SEVEN'
02AF	44D7	542	JMP T4S6 ; 'SIX'
02B1	1204	543	DAC4: JB0 T4S9 ; 'NINE'
02B3	44D5	544	JMP T4S8 ; 'EIGHT'
		545	
02B5	72CD	546	STEEN4: JB3 BAA4
02B7	52C3	547	JB2 SAB4

LOC	OBJ	SEO	SOURCE	STATEMENT
02B9	02BF	549	JB1	BAC4
02BB	12D2	549	JB0	T4S11
02BD	4403	550	JMP	T4S10
02BF	12F6	551	BAC4:	JB0 T4S13
02C1	44D1	552	JMP	T4S12
02C3	32C9	553	BAC4:	JB1 BAC4
02C5	12FA	554	JB0	T4S15
02C7	44E7	555	JMP	T4S14
02C9	12E4	556	BAC4:	JB0 T4S17
02CB	44E5	55	JMP	T4S16
02CD	12E1	558	BAA4:	JB0 T4S18
02CF	44E3	559	JMP	T4S17
		560		
		561 :	ROUTINE TO CALL UPON TRAINEE #4 TO SPEAK 'ZERO' THRU 'TWELVE'	
		562		
02D1	19	563	T4S12:	INC R1
02D2	19	564	T4S11:	INC R1
02D3	19	565	T4S10:	INC R1
02D4	19	566	T4S9:	INC R1
02D5	19	567	T4S8:	INC R1
02D6	19	568	T4S7:	INC R1
02D7	19	569	T4S6:	INC R1
02D8	19	570	T4S5:	INC R1
02D9	19	571	T4S4:	INC R1
02DA	19	572	T4S3:	INC R1
02DB	19	573	T4S2:	INC R1
02DC	19	574	T4S1:	INC R1
02DD	F1	575	T4S0:	MOV A+0B1
02DE	B733	576	T4SPK:	MOV R1, #033H
02E0	04B3	577	JMP	SPEAK4
		578		
		579 :	SPEAK 'THIRTEEN' THRU 'NINETEEN'	
		580		
02E2	19	581	T4S19:	INC R1
02E3	19	582	T4S18:	INC R1
02E4	19	583	T4S17:	INC R1
02E5	19	584	T4S16:	INC R1
02E6	19	585		INC R1
02E7	19	586	T4S14:	INC R1
02E9	19	587		INC R1
02EB	19	588		INC R1
02EA	19	589		INC R1
02EE	F1	590		MOV A+0B1
02EC	14B3	591	TEEN4:	CALL SPEAK4
02EE	1D14	592	TEN4A:	MOV A, #10101B
02F0	14B5	593		CALL TEN4A
02F2	0BEE	594		LD TEN4A
02F4	44DE	595		HF T4S1
		596		
02F6	0211	597	T4S13:	LD #10111B
02F8	44E1	598	JMP	T4S14
		599		
02FA	0211	600	T4S15:	LD #10111B
02FC	44E1	601	JMP	T4S16
		602		

LOC	OBJ	SEQ	SOURCE STATEMENT
		603 ;	SPEAK 'TWENTY'
		604	
02FE 2310		605 T4S20:	MOV A,#10000B
0300 14B3		606	CALL SPEAK4
0302 2313		607 T4S2A:	MOV A,#10011B
0304 14B5		608	CALL WAIT4
0306 0602		609	JZ T4S2A
0308 04B3		610	JMP SPEAK4
		611	
		612 ;	*****
		613	
		614	
		615 ;	SPEAK 'POINT'
		616	
030A 231A		617 T1SPT:	MOV A,#11010B
030C 04A7		618	JMP SPEAK1
030E 231A		619 T2SPT:	MOV A,#11010B
0310 04AB		620	JMP SPEAK2
0312 231A		621 T3SPT:	MOV A,#11010B
0314 04AF		622	JMP SPEAK3
0316 231A		623 T4SPT:	MOV A,#11010B
0318 04B3		624	JMP SPEAK4
		625	
		626 ;	SPEAK 'ERROR'
		627	
031A 231B		628 T1SERR:	MOV A,#11011B
031C 04A7		629	JMP SPEAK1
031E 231B		630 T2SERR:	MOV A,#11011B
0320 04AB		631	JMP SPEAK2
0322 231B		632 T3SERR:	MOV A,#11011B
0324 04AF		633	JMP SPEAK3
0326 231B		634 T4SERR:	MOV A,#11011B
0328 04B3		635	JMP SPEAK4
		636	
		637 ;	*****
		638	
032A 8A50		639 DELAY:	MOV R2,#050H ; DELAY SUBROUTINE, 100MSEC PER R5 BIT
032C 8EFF		640 LOOP1:	MOV R3,#0FFH
032E 8E2E		641 LOOP2:	DJNZ R3,LOOP2
0330 EA2C		642	DJNZ R2,LOOP1
0332 ED1A		643	DJNZ R5,DELAY
0334 93		644	RETR
		645	
		646 ;	CONDITION THE ACCUMULATOR FOR THE DECODE ROUTINE
		647	
0335 AA		648 CACC:	MOV R2,A
0336 530F		649	ANL A,#0FH
0338 030F		650	XRL A,#0FH
033A 93		651	RETR
		652	
		653 ;	*****
		654	
		655 ;	INTERRUPT ROUTINE TO STORE A WORD IN THE STACK
		656	
033E 05		657 INTER:	SEL R81

LOC	OBJ	SEG	SOURCE STATEMENT		
0330	AA	658	MOV	A, #0	: STORAGE
0330	22	659	NEWLOC: IN	A, #0B	
033E	AE	660	MOV	R3, A	: STORAGE
033F	AC	661	MOV	R4, A	: STORAGE
0340	530F	662	ANL	A, #0FH	
0342	530F	663	JRL	A, #0FH	
0344	9E4C	664	JNZ	ICON	: IF ZERO THEN WORD IS 'ERROR'
0346	8800	665	MOV	R0, #1	: RAM OFFSET
034E	7495	666	CALL	SUBB	
034A	FA	667	MOV	A, R1	
034B	93	668	RETR		
		669			
034C	FE	670	ICON: MOV	A, #0	
034D	B251	671	JBS	INA	
034F	645E	672	JMP	STOR1	: REGISTER R0 FROM 8748
0351	927D	673	INA: JB4	STOR2	: REGISTER R2 FROM 8748
0353	6466	674	JMP	STOR1	: REGISTER R1 FROM 8748
		675			
0355	5300	676	STOR0: ANL	A, #0C0H	
0357	430E	677	JRL	A, #0EH	: CODE ACC TO XX00/1110 TO SAY 'POINT'
0359	AE	678	MOV	R3, A	
035A	B801	679	MOV	R0, #1	: RAM OFFSET FOR POINT
035C	7495	680	CALL	SUBB	
035E	FC	681	MOV	A, R3	
035F	AE	682	MOV	R3, A	
0360	B800	683	MOV	R0, #0	: RAM OFFSET FOR LS DIGIT
0362	7495	684	CALL	SUBB	: ACC GETS '(NUMBER)'
0364	FA	685	MOV	A, R2	
0365	93	686	RETR		
		687			
0366	530F	688	STOR1: ANL	A, #0FH	: CHECK FOR 8748 R2=1 OR 2
0368	966D	689	JNZ	STR1A	
034A	49	690	JRL	A, R1	: CODE ACC TO XX(R1)/XXXX
036B	927B	691	JB4	STR1B	
036D	FB	692	STR1A: MOV	A, R3	
036E	530F	693	ANL	A, #0CFH	: CODE ACC TO XX00/XXXX
0370	49	694	JRL	A, R1	: SET B5 OR NOT
0371	4010	695	JRL	A, #010H	: 50 AS TO SAY 'ZERO'
0373	AE	696	MOV	R3, A	
0374	B800	697	MOV	R0, #0	: RAM OFFSET FOR SECOND DIGIT
0376	7495	698	CALL	SUBB	
037B	D37B	699	STR1B: JIRF	STR1B	: LOOP TILL NEW VALUE GIVEN
0374	A43D	700	JMP	NEWLOC	
		701			
037C	5900	702	STOR2: MOV	A, #0	
037E	328B	703	JE1	A, #0E	: FOR 'TWENTY'
0380	1284	704	JBC	A, #0E	: SET 10 THRU 19
0382	617B	705	JR	A, #0	
0384	B920	706	NOTPER: MOV	A, #010H	: R1 = 0010/0000 FOR 8748 R2=1
0386	647B	707	JR	A, #0	
0388	B910	708	NOTPER: MOV	A, #001H	: R1 = 0001/0000 FOR 8748 R2=2
038A	5300	709	ANL	A, #0FH	
038C	4300	710	JRL	A, #0H	: ACC ACC TO XX00/1101 TO SAY 'TWENTY'
038F	AE	711	MOV	R3, A	
039F	A604	712	MOV	R0, #0	: RAM OFFSET FOR 45 DIGITS

LOC	DBJ	SEQ	SOURCE STATEMENT
0391	7495	713	CALL SUBB
0393	6478	714	JMP STR1B
		715	
0395	FB	716	SUBB: MOV A,R3
0396	F2A5	717	JB7 WHOAA
0398	02A1	718	JB6 WHOBB
039A	232E	719	MOV A,#2EH ; TRAINEE #1 2E,2F,30,31,32
039C	68	720	SUBBRT: ADD A,R0 ; ADD IN OFFSET
039D	A8	721	MOV R0,A ; USE AS POINTER
039E	FB	722	MOV A,R3
039F	A0	723	MOV @R0,A ; STORE DATA
03A0	83	724	RET
		725	
03A1	2329	726	WHOBB: MOV A,#29H ; TRAINEE #2 29,2A,2B,2C,2D
03A3	649C	727	JMP SUBBRT
		728	
03A5	02AB	729	WHOAA: JB6 WHOCC
03A7	2324	730	MOV A,#24H ; TRAINEE #3 24,25,26,27,28
03A9	649C	731	JMP SUBBRT
		732	
03AB	231F	733	WHOCC: MOV A,#1FH ; TRAINEE #4 1F,20,21,22,23
03AD	649C	734	JMP SUBBRT
		735	
		736	
		737	
		738	END

USER SYMBOLS

AMASK1 0010	AMASK2 0020	AMASK3 0040	AMASK4 0080	BAA1 0145	BAA2 01C7	BAA3 024B	BAA4 02C0
BAB1 013B	BAB2 01BD	BAB3 0241	BAB4 02C3	BAC1 0137	BAC2 01B9	BAC3 023D	BAC4 02BF
BAD1 0141	BAD2 01C3	BAD3 0247	BAD4 02C9	BUSY 0092	CACC 0335	CLEAR 0019	CLR4 0074
DAC1 0129	DAC2 01AB	DAC3 022F	DAC4 02B1	DAY 00C7	DEC1 011F	DEC2 01A1	DEC3 0225
DEC4 02A7	DEC0D1 0104	DEC0D2 0186	DEC0D3 020A	DEC0D4 028C	DELAY 032A	DEV 00E5	DIC1 011B
DIC2 019D	DIC3 0221	DIC4 02A3	DOC1 0125	DOC2 01A7	DOC3 022B	DOC4 02AD	GETCON 003A
GETNXT 0036	ICON 034C	INA 0351	INDATA 0023	INTER 033B	LAPA 0046	LOOP1 032C	LOOP2 032E
LOPO 0040	MAIN 002D	NEWLOC 033D	R2TEEN 0384	R2TWEN 0388	RESDEL 009E	RESEE 0095	RESEQ 0094
RESET 0009	RESRER 00A5	SPEAK1 00A7	SPEAK2 00AB	SPEAK3 00AF	SPEAK4 00B3	STBRET 00DE	STEEN1 012D
STEEN2 01AF	STEEN3 0233	STEEN4 02B5	STORG 0355	STOR1 0366	STOR2 037C	STR1A 036D	STR1B 037B
STORB1 00DC	STORB2 00D8	STORB3 00D4	STORB4 00D0	STORC 00C9	SUBB 0395	SUBBRT 039C	T1S0 0155
T1S1 0154	T1S10 014B	T1S11 014A	T1S12 0149	T1S13 016E	T1S14 015F	T1S15 0172	T1S16 015D
T1S17 015C	T1S18 015B	T1S19 015A	T1S2 0153	T1S20 0176	T1S2A 017A	T1S3 0152	T1S4 0151
T1S5 0150	T1S6 014F	T1S7 014E	T1S8 014D	T1S9 014C	T1SER1 0100	T1SERR 031A	T1SPK 0156
T1SPT 030A	T1SPT1 0102	T2S0 01D7	T2S1 01D6	T2S10 01CD	T2S11 01CC	T2S12 01CB	T2S13 01F0
T2S14 01E1	T2S15 01F4	T2S16 01DF	T2S17 01DE	T2S18 01DD	T2S19 01DC	T2S2 01D5	T2S2C 01FB
T2S22 0204	T2S2A 01FC	T2S3 01D4	T2S4 01D3	T2S5 01D2	T2S6 01D1	T2S7 01D0	T2S8 01CF
T2S9 01CE	T2SER2 01B2	T2SERR 031E	T2SPK 01D8	T2SPT 030E	T2SPT2 01B4	T3S0 025B	T3S1 025A
T3S10 0251	T3S11 0250	T3S12 024F	T3S13 0274	T3S14 0265	T3S15 0278	T3S16 0263	T3S17 0262
T3S18 0261	T3S19 0260	T3S2 0259	T3S20 027C	T3S2A 0280	T3S3 0258	T3S4 0257	T3S5 0256
T3S6 0255	T3S7 0254	T3S8 0253	T3S9 0252	T3SER3 0206	T3SERR 0322	T3SPK 025C	T3SPT 0312
T3SPT3 0208	T4S0 02D0	T4S1 02DC	T4S10 02D3	T4S11 02D2	T4S12 02D1	T4S13 02F6	T4S14 02E7
T4S15 02FA	T4S16 02E5	T4S17 02E4	T4S18 02E3	T4S19 02E2	T4S2 02DB	T4S20 02FE	T4S2A 0302
T4S2 02DA	T4S4 02D9	T4S5 02D8	T4S6 02D7	T4S7 02D6	T4S8 02D5	T4S9 02D4	T4SER4 02BB
T4SERR 0326	T4SPK 02DE	T4SPT 0316	T4SPT4 02BA	TALA 00B9	TALK 00B5	TDA1 004C	TDA2 005B
TDA3 0052	TDA4 006C	TEEN1 0164	TEEN2 01E6	TEEN3 026A	TEEN4 02EC	TEN1A 0166	TEN2A 01EB
TEN3A 026C	TEN4A 02EE	TRA1 004A	TRA2 0056	TRA3 0060	TRA4 006A	TRET 0052	WADEL 00B7

WAIT1 0079 WAIT2 007D WAIT3 0081 WAIT4 0085 WATT 008B WAXX 0089 WHDAA 03A5 WHOEE 03A1
WHCCC 03AE

ASSEMBLY COMPLETE, NO ERRORS

WAIT1 0079 WAIT2 007D WAIT3 0081 WAIT4 0085 WATT 008B WAXX 0089 WHDAA 03A5 WHDBE 03A1
WHOCC 03AE

ASSEMBLY COMPLETE, NO ERRORS

END

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